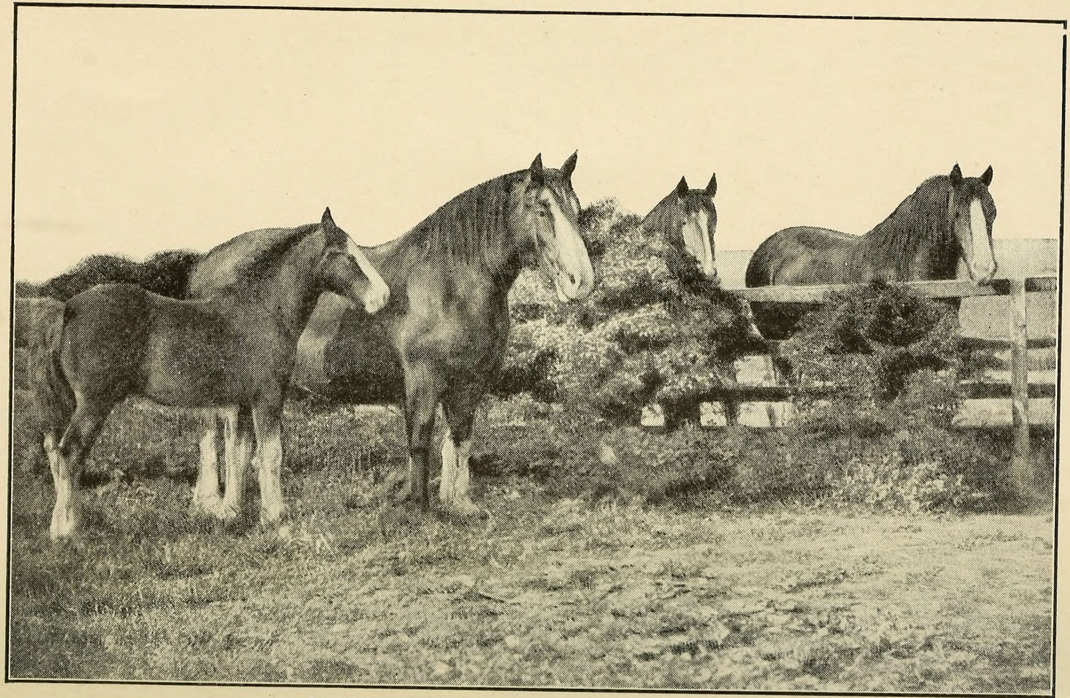

RATIONAL FEEDING PLUS RATIONAL BREEDING

# First Principles of Feeding Farm Animals

*A Practical Treatise on the Feeding of Farm Animals: Discussing the Fundamental Principles and Reviewing the Best Practices of Feeding for Largest Returns*

*By*

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## PREFACE

The fundamental principles of feeding animals are applicable to all parts of the country and to all parts of the world. For many years investigators have been at work on problems of nutrition and on interpreting the data obtained. As a result the student farmer has now at hand useful suggestions that will assist in handling the feeding problems of the farm to the best advantage. The man who feeds in a scientific manner is able not only to use his feeding stuffs more economically but he can obtain animal products more cheaply than can his neighbor who ignores the helps that science offers him. To these facts the author himself can testify. He not only has been a teacher of animal nutrition for many years, but has had a life-time experience also with the practical problems of feeding in feed-lots and stables.

The volume herewith presented discusses the first principles of scientific feeding and aims to interpret them so as to be equally useful to student, stockman and farmer. In this presentation, the needs of the teacher of animal feeding have also been kept in mind at every step, the object being to set forth the several phases in pedagogical as well as utilitarian form.

C. W. Burkett.

New York, July, 1912.

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# CHAPTER I

## THE SOIL, THE PLANT, THE ANIMAL

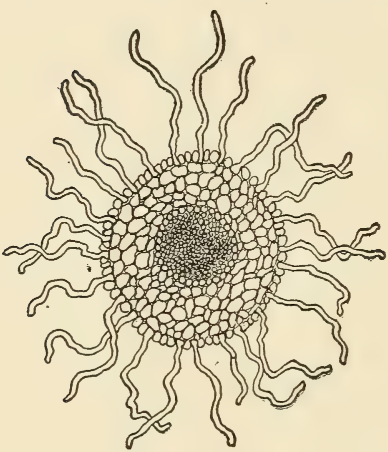
**How Nature Is Balanced.**—The soil, the plant, and the animal represent the three great fields of agricultural activity. They are dependent upon one another, each giving to, or receiving from, the others the things vital to its very existence. Without a soil, there would be, of course, neither plant nor animal life; without plants there could be no animals; and without plants or animals there would be a useless, if not a barren soil.

The three divisions of nature have come in natural order. First, the soil; then tiny plants, that were succeeded in time by other plants of a higher form, to which animals welcomed themselves, satisfying their appetites and nourishing their bodies with what they secured as food. Soil is food for plants, the plant is food for animals, and the dead animal or plant is food for the soil.

**Plant Food a Small Part of Soil.**—The whole of the soil is not plant food—only certain elements: chemical elements, we call them. In all nature there are 81 known distinct substances or elements. They are called elements because they represent distinct substances not one of which can be broken up into two or more other distinct substances. Common table salt is not an element, since it can be separated into two elements, sodium and chlorine. Neither

sodium nor chlorine can be divided into two or more substances, and hence each is a fixed unit or substance, known by the term element.

Of the 81 elements to be found in the world only 12 enter in the life of plants and animals. These 12 are very important because they are positively necessary to plants or animals. They are the very basis of life. The body of the animal is composed of the elements found in plants, yet the plant must grow in order to make it possible for the animal to grow. From the air and the soil our cultivated plants gather the chemical elements together, and with them build plant tissue. By means of roots, the soil is searched in every direction for soluble plant food, and this is drawn into the plant. The leaves in the air, also at work, entice into their being the floating carbon which, trapped and held, is mixed, as it were, by means of cellular life with the soil elements that have been carried into the plant in the soil water. As a result compounds are formed, the cells enlarge and increase,



CROSS SECTION OF ROOT HAIR

Soluble plant food is carried into the plant through root hairs. These are very small. The part pictured here is greatly magnified.

the plant becomes bigger. It grows. In other words, the plant, by feeding on soil and air, is enlarged through growth.

**Elements of Plant and Animal Life.**—The elements that enter into plant and animal growth are the following:

**Iron,** an element of universal use. All soils contain it.

**Calcium,** a yellowish metal, abundantly found in limestone soils.

**Potassium,** a whitish metal and soft. It is called potash when united with oxygen.

**Sodium,** soft and light, and when united with chlorine forms ordinary salt.

**Magnesium,** is white in color and a hard metal.

**Aluminum,** looks like silver and is very hard.

**Silicon,** a substance earthy in appearance and, next to oxygen, the most abundant element in the earth crust.

**Sulphur,** associated with nitrogen in the protein compounds.

**Phosphorus,** soft and yellow, often lacking in cultivated soils.

**Chlorine,** a colorless gas which, when united with sodium, forms common table salt.

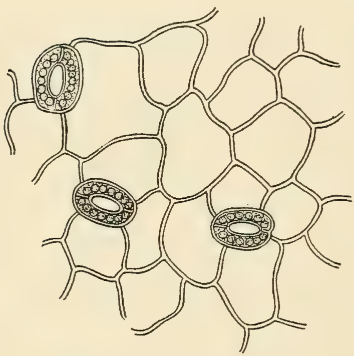
**Hydrogen,** the lightest known substance, a colorless gas. United with oxygen it forms water.

**Oxygen,** a colorless and abundant gas. One-fifth of the air, one-half of the earth's crust, and eight-ninths of the water of the world is formed of it.

**Carbon,** a principal substance of plants and animals. It is found in soil and air. Animals give it off in breathing and plants take it in through their leaves. United with oxygen it makes carbon dioxide of the air, the principal source for plants to get their supply.

**Nitrogen,** a gas in its free state. Both plants and animals require it, and four-fifths of the air is composed of it.

**Elements are United.**—Few of these elements exist in the soil in a free state. Two or more have united. In this association they exist as compounds. Thus nitrogen, potassium and oxygen united form potassium nitrate ($KNO_3$); and hydrogen and oxygen united form water ($H_2O$). So, throughout the world, various combinations of these elements are found and are known as chemical compounds.



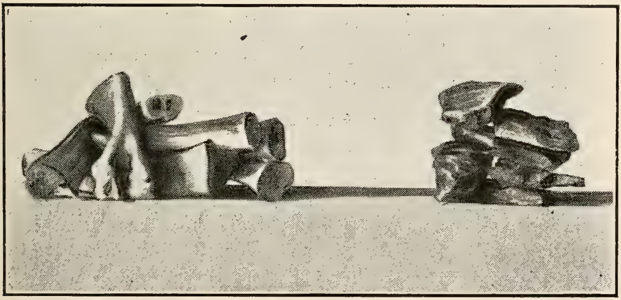
STOMATA, OR LEAF MOUTHS

As seen under the microscope on the underside of the leaf. Carbon through the stomata is admitted to the plants in the form of carbon dioxide or carbonic acid gas.

**Cycle of Life.**—The elements here described as essential to plant growth are needed by animals also. But animals neither can gather them from the soil and the air, nor would it be possible for animals to

use them if they could. Obtained in the form that plants utilize they would be poison to animal life. Nature's way is different. Plants grow: which means they feed on the element compounds. But, young or mature, these same plants are food for animals. The elements, by means of the plant cells, have been worked up into plant tissue; and as such animal forms of life are sustained.

The animal cannot feed from soil and air direct.



Two Sources of Phosphorus

In the early days bones were gathered for fertilizing. The Indians used fish. Today the phosphoric acid of fertilizers is secured largely from ground bone or finely ground phosphate r

It is necessary for the plant to take these elements and build them into tissue first. On this plant tissue the animal feeds. After the animal dies, with its decay and decomposition, come the changes of animal tissue back to soil and air—back to the original materials they go again, as they were before the time when captured by roots and leaves and made into plants. But once back in soil and air the same story is repeated: another capture is made by

other roots or leaves, that new plant tissue may be made for another generation of animal life.

It is in this manner that the plant grows out of the soil and the air, the animal out of the plant, the soil out of the animal. The animal when living contributes active supplies, and when dead both humus and mineral ingredients are returned to the soil; the soil thus reinforced favors the new plants now growing in it; and the new plants, now more abundantly nourished, more effectively take care of the animals. Thus we have the cycle of life: from the plant is fed the animal; from the animal is sustained the soil; from the soil is nourished the plant.

**The Farm and the Animals.**—The best system of agriculture is based upon good crops and well-bred live stock. With these to be possible the following propositions must always be kept in mind:

1. The soil must be rich in the simple elements of plant food, that there may be an abundance of farm crops.
2. The farm crops must be adapted to their climatic and soil environments so as to produce from the elements in the soil the largest growth of desirable plant life for animal food.
3. Superior farm stock must be raised in order to produce cheaply the maximum quantity of high-quality meat and milk or wool and labor with the least expenditure of food.

**Supply of Plant Food.**—The farmer, to make agriculture remunerative, must adapt his work to what falls within these lines. He must enrich the soil.

He must aid nature in her efforts to maintain the present supply of plant food, to increase it, and to make unavailable plant food available so as to be assimilable to plants. After death of plant or animal the plant food contained in these organic forms is still unusable by plants until decay and decomposition have done their work. In a like manner the soil itself holds locked-up plant food in

Poor Cattle Often Indicate Poor Land

If soils have been intelligently tilled and manured they produce good pasture and profitable crops. These in turn furnish appetizing and nutritious feed for the rapid development of farm stock. If the grass is scanty live stock will reflect the condition of the land.

its storehouses. The farmer's work is to find the key that will unlock this plant food. Shallow plowing, removal of organic matter, carelessness in tillage, excessive water, bad bacteria, all unite in making soils hard, dead and lifeless, and when so made they refuse to release their soil-food possessions, a condition that either prevents plant growth altogether; or, if not that severe, in so lessening the vigor as to give a crop of small worth.

**Poor Grass, Poor Cattle.**—If the plow be turned loose in these soils, and the land be drained and limed and carefully and intelligently tilled and cultivated; at the same time if organic matter be added by means of stable manure, legumes or green crops, the soils will quickly change from their unproductive condition into the other state that produces remunerative crops. When the soil is poor the

DOUBLE GOOD FROM SOY BEANS

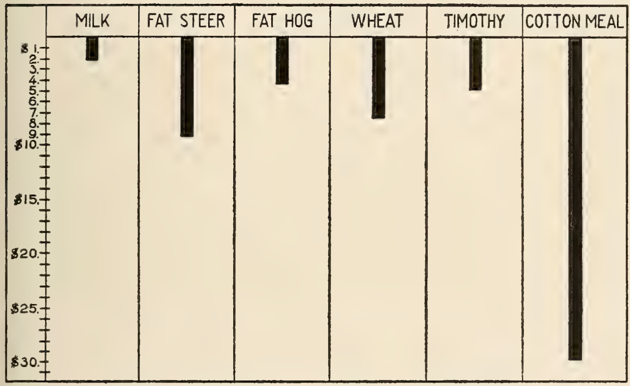
This magnificent crop of soy beans will be a blessing to both soil and animals. They enrich the land and provide a feeding crop of the highest excellence.

crops are poor; when the crops are poor the animals are poor; when the animals are poor the soils are poorly nourished.

**Soil Improvement and Live Stock.**—The ideal agriculture maintains itself. Every system of farming should consist of both plant production and animal feeding. The importance of this is seen from the following:

1. **Clover, cowpeas, alfalfa** and other legumes are needed to build up the soil. These, together

with the cereal crops, are the very kinds of plants we want for horses, cattle, sheep and swine. They should be grown, and especially the legumes, to improve the soil; which done there will follow larger yields of grain, forage and grass crops that, either directly as money crops, or indirectly as feeding crops, will make larger the total farm returns in money or production.




WHAT THE FERTILIZING ELEMENTS ARE WORTH

The drawing shows the money value of the fertilizing materials of several farm products in a ton of each substance. These should be considered in connection with the commercial worth of each product.

2. **Natural manures and fertilizers** are needed for improving the soil. The more live stock there is on each farm the greater will be the quantity of manure made, and hence a less amount of purchased fertilizers will be required. The fertilizer bill is a great farm tax. A part of it would be unnecessary if business-like farming were followed. It should be a set policy to purchase as much of the

fertilizers as possible in the form of feeding stuffs. Take a dollar and get cottonseed meal, gluten, bran or tankage, but instead of applying these direct to the soil as sources of nitrogen, phosphorus and potassium, first feed them to live stock to get the

CONVERTING RAW MATERIAL INTO FINISHED PRODUCTS

Dairy cows are excellent machines for converting the rough products of the farm into human food.

value of the organized nature of the elements as feed. Then, this accomplished, the resulting manure will provide plant food for the land.

The important difference between plant food or fertilizers and animal food or plants is in the fact that plants take the unorganized chemical elements and manufacture or build or organize them into living tissue, which is the plant or the fruit of the

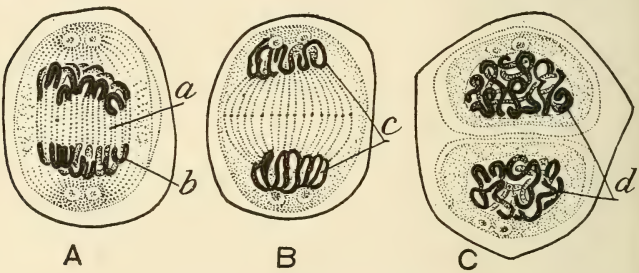
plant, and as such is the food of the animal. Feed the plant or its fruits to live stock and get meat or wool or milk or labor from the organized tissue; then let the animals return these, now disorganized and broken up, back to the soil, in manure or excrement, so as to get a new growth of plants. By letting live stock prepare the plant food you gain in both ways.

3. **The animal changes raw materials** into finished products. The feeder can take corn, grass, clover, bran, gluten and other feeding stuffs and from them compound balanced rations for all classes of live stock. These are simply raw materials, and as such command low prices if placed on the markets of the world. An increased value follows their change into a finished product. A dairy cow, fed a mixture of 25 pounds of corn stover, clover hay, wheat bran and gluten, worth a few cents, will produce butter or milk worth many cents. The increased value is the result of the change from the form of raw materials into a finished product at once usable as food for human beings.

## CHAPTER II

# WHAT FEEDING STUFFS CONTAIN

**How Plants Grow.**—Plants get their food from the soil and the air. When supplied abundantly with food, and surrounded by favorable conditions like warmth, moisture, sunlight and an agreeable soil free of weeds and insect enemies, they grow




How an Animal Cell Divides

Here is shown nuclear and cell division. The letters A, B and C indicate the successive stages. The region of the nucleus is *a;* cytoplasm or protoplasm, *b;* and the beginnings of the daughter nuclei, *c.* The letter *d* shows how the original cell has divided internally into two, each with a large nucleus. (After Guignard.)

rapidly and produce bountifully. Their method of using food is much different from that of animals; and their digestive system is of another order.

**Plant Cells.**—A plant is formed of myriads of cells. These increase in numbers as the plant grows larger. Stated in a simple way, the *cell* is an inclosed sac within whose walls are the juices and other substances required for growth and develop-

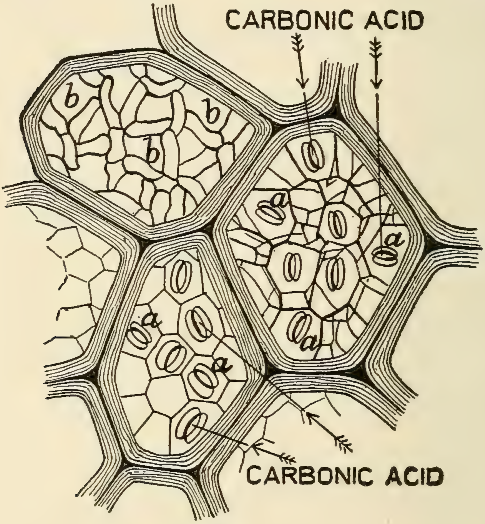
ment. The cell walls are made up of a woody substance called *cellulose.* In green and growing plants this cellulose is thin and tender, but as the plant matures it becomes hard and woody.

The roots, trunk, leaves and all other parts of the plant are formed of cells. Plant food in the soil is made soluble in soil moisture, and by means of the cells comprising the roots the soluble substances are sucked in and carried in water to all parts of the plant. The process by which this is done is known as *osmosis.* The soluble plant food left in the cells as the water passes along is met by the carbon that has also been passed into the cells, not through the roots, however, but through the leaves, and thus brought together all building materials are at hand for the manufacture of the plant compounds. The master builder is the *protoplasm* tucked away in the cells. No one knows just what protoplasm is, but it represents life, without which there could be no growth.

**Building Plant Tissue.**—The building work is done in the plant cells, within whose tiny walls the compounds are formed. These cells within which this process is going on are either enlarged themselves or else the compounds are used for making new cells. Every live, active cell contains protoplasm, the life principle. Herein is contained the vital spark that makes all growth possible.

**Starch.**—When the soluble soil material or plant food has been carried up through the long channel of cells and reaches the leaves, it is brought in contact with the carbon dioxide that has been pulled into

the leaf through the little mouths on the undersides of the leaves. There these various compounds are upset and disintegrated through the action of heat, sunlight, protoplasm and chlorophyll, with the result that a grain of *starch* is made out of the water and




UNDERSIDE OF A LEAF

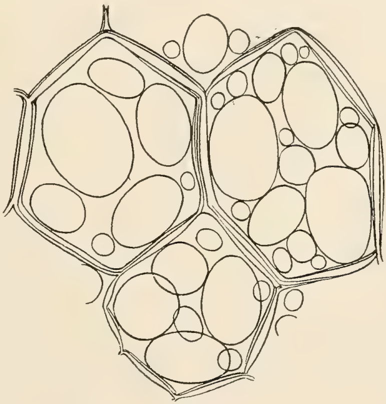
When studied under the microscope the underside of a leaf appears as sketched above. The letter *a* shows the stomata or mouths, and *b* the cells of the leaf.

carbonic acid gas. Some of these starch grains are changed by protoplasm into sugar, which, being readily soluble, soon is transferred by diffusion from cell to cell and left in those cells that need it the most.

**How Plants Use Starch.**—Starch is not the life substance of the plant, but helps to make it. It is

necessary, because not only more life substance is required as the plant grows larger, but because in one kind of work that the plant does some of the life substance is used up. Not all of the starch, therefore, remains as originally formed; some of it is assimilated along with other foods taken up by the roots, and living material is made.

**Protein.**— The formation of the *protein constituents* is more complex than the formation of starch. In a general way it may be said that starch or some starch derivative is united in the cells with nitrates and sulphur that have been brought into the plant from the soil. The living matter, or protoplasm, then breaks up the nitrates in the active cells, uniting them in some way with starch, with the result that a protein compound is formed.



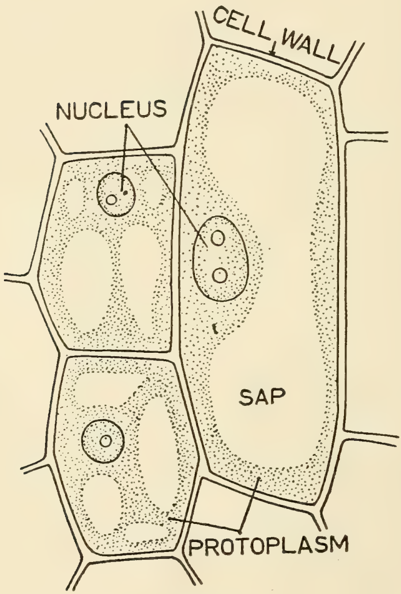
STARCH CELLS

This is the way the starch cells from potato tubers look when seen under the microscope.

**Fat or Oil.**—Oil is made out of the same chemical elements that enter into the building of starch grains. Both are formed of carbon, hydrogen and oxygen. In the oil compounds there is a larger

number of the carbon and hydrogen units in proportion to the oxygen than in the case of starch. While all plants contain some oil or fat in their woody tissue, the great bulk of it is deposited in the seed or the fruit.

**Protein** differs in composition from oil or starch in having nitrogen and sulphur in addition to carbon, hydrogen and oxygen.



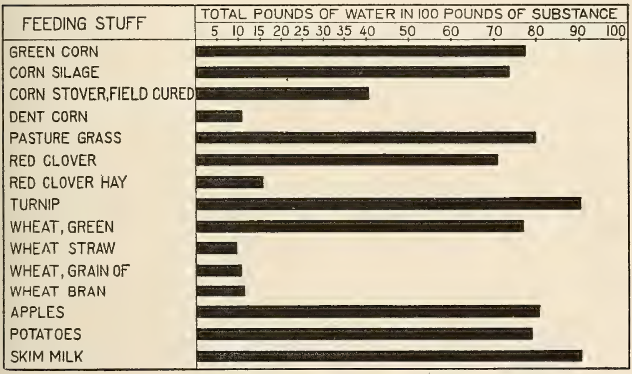

Leaf Cells

How the cells from the interior of a leaf look when seen under the microscope.

**What Plant Building Means.** Before the simple elements are taken into the plant they are of little value. No animal can use them as food; they cannot be burned to furnish heat; and they store up no energy to carry on any of the world's work. What a change the plant makes of them! Without value in soil and air, these elements when taken into the plant and built into tissue at once become of vast importance. They become the source of all animal food, and, constructed

into vegetable life, supply the human race with most of the essential things for comfort, life and food.

**Ash or Mineral Materials.**—Starch, oil and protein are not the only constituents found in plants; ash or mineral matter is found in every form of plant life. This is observed when any vegetable material has been burned. The organized condition

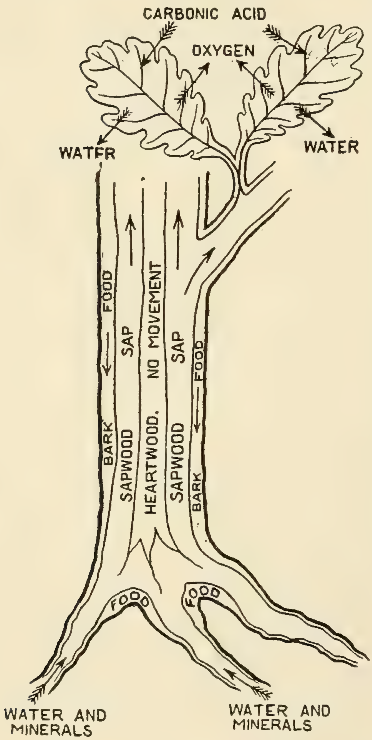



GROWING PLANTS CONTAIN MUCH WATER

Several common feeding stuffs are here compared to show the large quantities of water they contain. Note the change when harvested and cured as dry provenders.

is destroyed, but the ash remains. In green plants or fodder or the vegetables the minerals are always at hand, and when eaten by man or beast they go to form bone, teeth and other tissue structures of the body. In most feeding stuffs sodium and chlorine are lacking, but the deficiency is corrected by the artificial supply of common salt. Poor teeth, small and weak bones in children and domestic animals result when an insufficient amount of ash

or mineral material is furnished in the food. A variety of food, including coarse fodders and the legumes, makes it possible to supply the mineral materials in abundance.




How the Sap Currents Move

The unmanufactured sap current taken into the plant through the roots moves upward, while the manufactured product of the leaves moves downward.

**Water** is found in all plants, even in those dead and air-dry. Young growing plants contain much, often three-fourths or more of their weight. Do you wonder now why water in the soil is so important for the production of good crops? The plant not only must have the water, but the only way it can make use of it is to carry it into the plant through the roots.

Water serves as a carrier of plant food through the roots to every part of the plant. It is to the plant what blood is to the animal. Some people think that dew or rain on the leaves is of value to

the plant. But is it? The mission of the water is to dissolve plant food in the soil and when in solution to get it into the plant. Surely a heavy dew on a crop of corn dissolves no plant food in the earth, and certainly carries none into the plant. Dew, then, is not a means of feeding the plant. What water the plant gets is obtained, as has been explained, from the soil by means of the roots.

**Crude Fiber** serves as a framework of the plant. It is to the plant what bones and skeleton are to the animal. It is made of carbon, hydrogen and oxygen, the same elements that go to form starch. Immature and young plants are tender because the crude fiber is tender; as the plant matures, the fiber hardens and toughens, as we find it in hay and corn stover and trees.

**Grouping the Plant Constituents.**—When the chemist analyzes plants he finds many kinds of compounds. He finds that while there is a physical difference, the chemical elements are invariably united in definite combinations producing definite compounds. For the sake of convenience the plant's constituents may be grouped as follows:

I. Ash.
II. Water.
III. Protein or compounds containing nitrogen.
IV. Nitrogen-free compounds or compounds containing no nitrogen.
    1. Starch.
    2. Crude fiber.
    3. Sugar, gums, etc.
V. Ether extract, or oil or fat.

**What the Plant Has Done.**—The relation between soil and plant is now apparent. The soil elements have been taken into the plant. From now on they lose their individual identity and, united in various ways, they now become organized compounds. They are no longer carbon, hydrogen and oxygen, but starch or sugar, or oil; or, if nitrogen and sulphur are added, they become protein compounds. The plant has now fulfilled its destiny and is ready to be used as food for the support of animal life.

**Elements and Their Symbols.**—For the sake of brevity the symbols or letters representing the various agricultural elements are often used, and for the purpose of becoming acquainted with them the list below is given:

| | |
|---|---|
| O—Oxygen | P—Phosphorus |
| H—Hydrogen | K—Potassium |
| N—Nitrogen | Mg—Magnesium |
| C—Carbon | Al—Aluminum |
| Cl—Chlorine | Fe—Iron |
| Na—Sodium | Si—Silicon |
| S—Sulphur | Ca—Calcium |

## CHAPTER III

## HOW FOOD IS DIGESTED

**Making Ready for Digestion.**—Digestion is more than chewing and swallowing. Both of these are important, but they are only the beginning of a complicated act that has to do with every constituent taken into the mouth as food, regardless of its nature, whether of vegetable or animal origin. Before the several ingredients composing the plant can be used as food they must be prepared for absorption into the system of the animal. This preparation takes place in the mouth, the œsophagus tube, the stomach and the intestines. Throughout the process various secretions are supplied to make assimilation and absorption into the system possible.

**What Is Done in the Mouth.**—When food is taken into the mouth, it is masticated by the teeth. While this is going on there are poured into the mouth large quantities of *saliva,* which soften and soak the foods and start digestion. The active principle of saliva is a soluble ferment called *ptyalin* that converts the starch into sugar. One authority states that the saliva of a horse will convert raw starch into sugar in 15 minutes. The organic matter contained in this secretion is formed by the cells comprising the structure of the salivary glands.

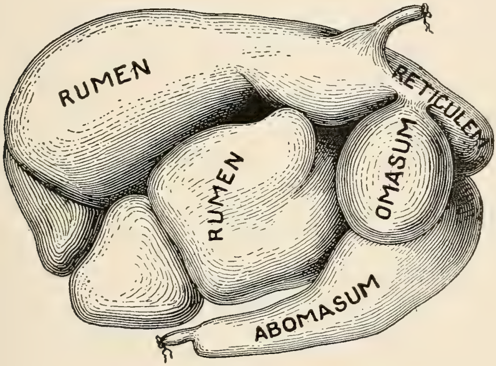
A large amount of saliva is soaked up by the food. This is often expressed as being as much as one-

tenth of the weight of the animal. Colin states that 84 pounds is secreted by the horse and 112 pounds by the cow in a single day. As a matter of fact, the nature of the food greatly influences the flow, although the control rests with the nervous system. The ferment of the saliva is inactive in young animals. It bears a close relationship to the development of the teeth. Starchy food, therefore, is not desirable for newly born farm animals nor for the human young. While bread, potatoes and other soft food of a starchy nature are frequently, if not commonly, given to children, it can be only to their hurt, for the reason the teeth slowly develop, thus failing to provide the ferment to prepare the starches for digestion, although moisture is naturally secreted by the glands.

**From Mouth to Stomach.**—The food, after being ground and mixed with the saliva, is forwarded to the stomach. Horses, hogs and humans have a single stomach compartment, while cows, sheep and goats have a different arrangement, embodying four divisions. With the former the stomach is comparatively simple. It is a single sac not capable of holding a large quantity at one time. On the other hand, in the ruminants, the family to which cattle and sheep belong, the stomach is large, and capable of considerable extension. The capacity of the stomach of the average horse runs from three to four gallons, and of the cow to as much as 50 gallons or more.

**The Compartments of the Cow's Stomach** are known as the *rumen,* or *paunch,* the *reticulum,* the

*omasum,* and the *abomasum.* The last is the true digestive stomach, the others are largely storage places for the saliva-mixed food. The first of these compartments is very decidedly a storing place where the food is placed until it is thrown back to




STOMACH OF RUMINANT

**The four main divisions of the ruminant's stomach are pictured here. The first three divisions are the storehouses for food until it is prepared for the fourth or true stomach.**

the mouth for further mastication. This act, or cud chewing, refers to rechewing the food so as to get it finer and better ground for digestion. The food, on leaving the mouth the second time, is passed through the rumen into the reticulum, then to the omasum and finally into the abomasum, or true stomach, where digestion is continued.

In the first compartment, or rumen, a churning process is carried on continually. Some think this division of the stomach is never wholly empty. An alkaline fluid is furnished here, as is the case also

in the second compartment. Food in the third compartment is subjected to a squeeze which dries it, forcing the extracted juices into the true stomach or fourth compartment.

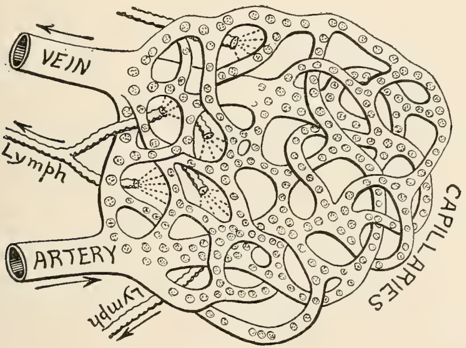
**Stomach Secretion.**—The stomach of every class of animals is lined by two kinds of membrane: one, similar in nature to the lining of the œsophagus tube, and the other that admits of secretion. These do not form a double coat but one blends into the other. The section giving off the secretion is known as the *villous coat.* It extends to the posterior end, and to the point where the small intestine joins with the stomach.

While in the stomach, the saliva continues the digestion of the starchy matter, and is assisted by the *gastric juice* that pours in from the stomach lining. This secretion has three constituents, *acid, rennet* and *pepsin.* The pepsin is a ferment, its work being to split up the protein compounds. The rennet is also a ferment, which assists in the digestion of milk. There is much of this secretion in calves. The gastric juice converts the protein substances into peptones.

The mucus glands of the stomach secrete *mucin,* a substance that lines the walls of the stomach, at all times.

**From Stomach to Intestines.**—The constant churning movement in the stomach causes the food to travel from the entrance to the exit, the small intestine. Up to this time there has been no absorption of the food into the body. Nor is diges-

tion yet complete. When the partly digested material or *chyme* leaves the stomach it passes into the *duodenum,* one of the three parts of the small intestine, and is subjected to further action of other digestive juices. Here the *bile,* the *pancreatic* and *intestinal* juices are admitted to complete the work. The bile, dark green or brownish in color, is secreted by the liver and acts in conjunction with the



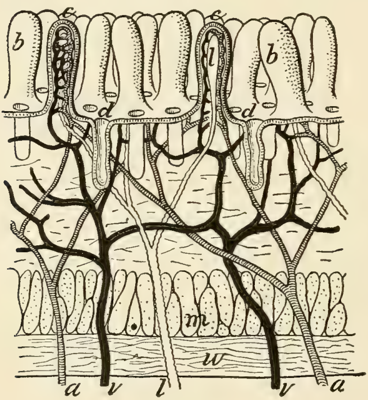

BLOOD PLASMA

This shows **blood** plasma passing out of the capillaries to feed the cells. It is there taken up by the lymph vessel.

pancreatic juice. The pancreatic juice, alkaline and watery, is secreted by the pancreas, or "sweet bread." The bile acts as a bowel regulator when the liver is active and healthy. The pancreatic juice has a treble function: it is able to change starch into sugar, protein into peptones, and the oils into fatty acids. The intestinal juices perform similar work.

**The Two Intestines** are not only important for storage purposes, but in them, particularly the

smaller, the real digestive act, the absorption of the nutriment in the food by the blood, takes place. Up to this point, although the fluids have been at work, there has been little if any active absorption into the system. The food up to now is in a sense outside the body; and there is no entrance or opening for it to get into the body, save through the cells that line this part of the digestive tract. In a way similar to that by which soluble plant food is admitted into the plant roots through the cell walls, so is the digested food, after it has been broken up and made soluble, absorbed through the cell walls of the intestines into the blood system of the animal.




VILLI CELLS

Section of intestine showing villi. The parts are as follows: *a*, arteries; *b*, villi; *c*, villi cut open to show lacteal (*l*), and blood tubes; *d*, glands; *m*, muscle; *v*, veins; and *w*, wall of intestine.

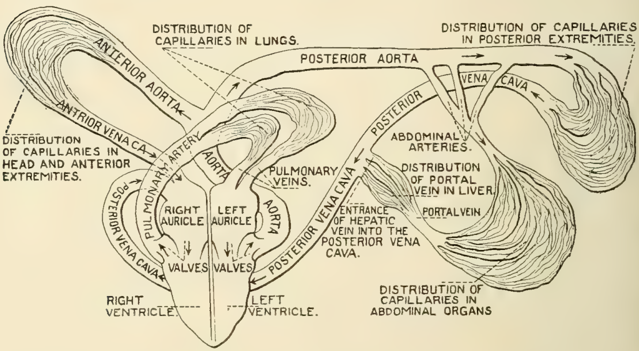
**From Intestines to Blood.**—When food is absorbed it is admitted either to the *capillaries* of the blood or to the *lymphatic* system. If collected by the capillaries the absorbed food is carried to the *portal vein*, thence to the liver and finally to the heart, where it is poured with the blue blood as it is brought in from all parts of the body. At this point the blood contains

both nutriment and the waste or broken-down matter of the body. The part of the absorbed food that enters into the lymphatic system is carried to the thoracic duct, which extends along the spinal column, and enters one of the main blood vessels. The *lymph* is blood without the red blood corpuscles. It wanders to all parts of the body, surrounds all the cells in all the tissues and carries to the cells the very kind of food they most need.

Once the food gets into the circulatory system it takes the regular course of the blood. In impure blood it goes to the right auricle of the heart, then to the right ventricle. This in turn contracts and forces the blood into the lungs, where oxygen is taken on and carbonic acid gas and other impurities are given off. From the lungs the blood, now red and pure, passes into the left auricle, and thence into the left ventricle, from which it is forced into the aorta, to be distributed to all parts of the body.

**Villi Cells.**—The digested food in the intestines is gathered in by the *villi* cells. The mucous membrane lining the small intestines possesses highly differentiated structures that appear as minute fingers. These tiny, hair-like projectiles reach into the intestinal mass for sugar, peptones and fatty acids, which they transfer, through the cells, into the absorbent vessels or lymphs that in turn empty the assimilated stores of food into larger and still larger vessels. This process continues until the whole of the nutritive fluid is collected in the circulatory system to become the very basis of the blood.

**Respiration.**—When the impure blood passes through the lungs, carbonic acid gas and other impurities are held back and in breathing are exhaled and thrown out of the system. At the same time oxygen is taken in with great greediness by the cells of the blood, which distribute it where needed in all parts of the body. When plants are growing, oxygen is released and thrown into the




How the Blood Circulates Through the Body

The blood is collected from the body and delivered into the right auricle, which on contracting, forces the blood into the right ventricle; this in turn contracts and forces the blood into the lungs, where oxygen is taken on and carbonic acid gas and other impurities are thrown off. From the lungs the blood is returned to the left side of the heart and distributed through arteries and capillaries to all parts of the body.

air. At the same time, by means of leaves, the carbonic acid gas is drawn in and used in the construction of the plant compounds. This was got from the air. The animal, in performing its functions and in building its tissue, inhales oxygen from, and exhales carbon dioxide into, the air. Thus it is that animals use what is waste to the plant and the plants use what is poison to the animal.

## CHAPTER IV

# USING FEEDS FOR BEST RESULTS

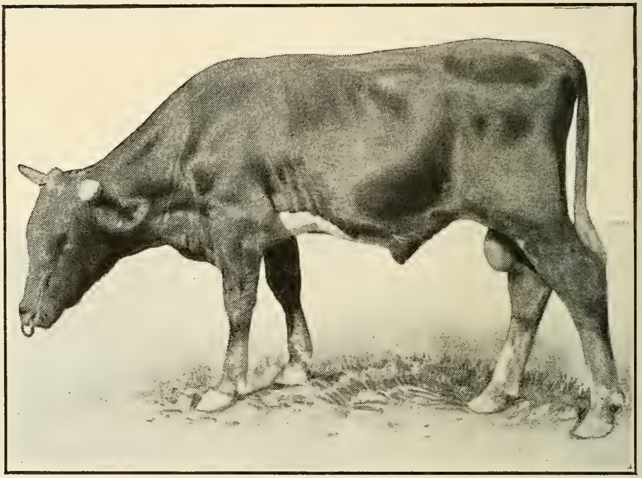
**Foods Must be Appetizing.**—Plants are most liked when young and tender. They are then agreeable to the taste and induce a maximum consumption. At this stage of growth little woody tissue has developed, the juices are abundant, the substances are freely acted upon by the secretions, and

CORN IN GOOD SHOCKS

Corn may be preserved for a time in shocks in the field. If left until winter, rains and snows cause rapid deterioration and great loss of feeding value.

the largest amount of nutriment is absorbed into the system. Feeds that are unappetizing and dis-

agreeable to smell or taste will be rejected, or if eaten at all will be only to satisfy hunger. The good feeder endeavors to tempt the taste and increase the appetite of his animals, that the largest possible consumption of food may be had to secure the quickest and largest returns.



A Steer that Was a Poor Feeder

Scrub animals as a rule are not good feeders. Pure-bred animals render a much better account of what they eat.

Since growth can result only from the food consumed, it follows as an undisputed conclusion that light feeding will retard development. Hence, not only good food must be provided, but much food also. Many a feeder owes his success to his ability to get before his animal a bountiful ration that is both wholesome and nutritious. Hunger may make

his animals partake of almost any kind of food, but nothing he can do will induce these same animals to eat a disagreeable or unappetizing food heartily enough to get a response much beyond their maintenance needs. Growth and production are invariably associated with well-flavored and appetizing food, even though they add nothing to the energy or nutritive value of the food.

**Digestibility Little Influenced by Quantity.**—Ordinarily digestion is but slightly influenced by big appetites. Heavy eaters are usually the most profitable animals. Fed to their full capacity they give as good an account of their food as when limited to half feeds. Food is digested and assimilated just as completely in full as in half-filled stomachs. The most rapid growth, or the largest milk flow, is to be had when the animal is permitted to eat to its full capacity; and this is another reason why the ration must be palatable and attractive to taste and smell.

**The Individual Character of the Animal** undoubtedly affects the proportion digested. Armsby has found that a pure-bred animal of superior breeding renders a better account of its food than a scrub. Of two animals supplied with the same feed, one will often persistently digest a larger proportion than the other. Often very greedy eaters show very poor fattening qualities.

In young animals the digestive power is apparently equal to animals of mature age.

**Digestibility Decreases as Plants Mature.**—All classes of plants show a striking diminution in

digestibility as they approach maturity, and this is very equally spread over all the constituents. The composition varies also, and for the same reason. Hence, no fixed nutritive value can be ascribed to the hay and fodder crops except in a general way. The young plant is always the most nutritious. The superior fattening quality of a pasture, as compared

Making Good Hay Is a Fine Art

Hay often is improperly made. If cut late it is less nutritious and appetizing. If soaked with rains, or the finer parts are lost by bad treatment, the feeding value will be decreased.

with that of the hay made from it, is clearly due to the fact that on land continuously grazed the animal is fed entirely on young forage, while hay will largely consist of the mature or nearly matured plants. If hay making is carefully carried out in good weather so the finer parts are not lost by bad treatment, or the soluble matter is not washed out by rain, the digestibility will not be diminished considerably.

Every kind of hay should be cured in the shock before being placed in the mow; otherwise it may become brown by heating and the digestibility of the protein and soluble carbohydrates be diminished.

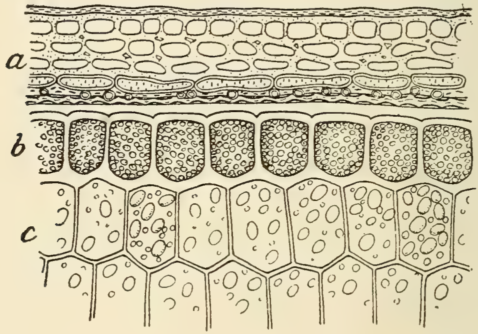
Early cut hay is richer in protein and contains less crude fiber than that cut late. The increased weight, due to the longer growing period, chiefly develops cellulose. As the plant ripens the more nutritious compounds move into the seed, and leave the food part of hay less valuable. The best time for cutting hay is when the plants are in blossom; the nutritious compounds at this time are distributed throughout the plants, and there is correspondingly less woody tissue.

**Shall Grain Be Ground?**—Many grain feeds increase their digestibility if they are ground. Corn, oats, wheat and other grains often are so hard that if passed into the stomach without mastication the digestive juices fail to do their full duty. While this is a true and an unfortunate condition, it does not always follow that it is good business management to grind these feeds. Experiments show that when corn, for instance, is ground the returns are increased from 8 to 15 per cent; yet the labor of hauling to and from the mill or of grinding the grain at home may mean a loss in the end.

This factor must be determined by each individual, for no cut-and-dried rule will apply. The custom of following cattle and horses with pigs to pick up the undigested grain or other food is both wise and profitable, and satisfactorily meets this condition.

**Steaming and Cooking Food.**—A great many devices have been placed on the market for the preparation of feeding stuffs for live stock. The labor and expense connected with the practice is usually unwarranted and uneconomical.

**What Most Influences Digestion.**—Feeding farm stock is a gentle art. The old adage, "the hand of the master fattens the flock," is a clear expression of the intimate relation that should exist between




FROM A GRAIN OF WHEAT

Traverse section near the outside of a wheat grain. The letters show the following: *a*, the husk (pericarp, integuments); *b*, cells with protein granules; *c*, starch cells. (After Tschirch.)

the feeder and the animals in his charge. Two men may provide the same feed for two lots of live stock, similar in kind, and far different results will be obtained at the end of a given period. The one studies his individual animals, knows each as if by name, takes an interest in its progress, endeavors at all times to help in case of mishap, and actually encourages, as if to induce greater endeavor. The other feeds the stock and lets it go at that.

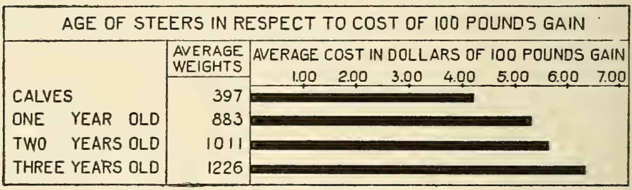
This personal touch is of great importance, and includes everything involved in the preparation of feeds that the highest digestibility may be secured. Rough treatment, bad quarters, irregularity in feeding, usually in themselves will overbalance the advantages gained in attempting to influence digestibility and larger consumption through better preparation for easier mastication, or through appeal to the taste and appetite.

The good feeder is a good judge of stock. He is careful, cautious, and habitually regular; endowed with virtues of patience, perseverance, and good common sense, he treats his animals as though they were children in a schoolroom. He watches every detail; if a slight change or modification of method is necessary, he sees that this is effected at once. He meets all contingencies as they arise, calmly and without excitement. Above all, he possesses a refinement of manner and disposition that causes his animals to know and love him. Thus they will repay in more willing labor or in more milk or in cheaper beef, pork or wool. Herein is the real secret of feeding the animals of the farm successfully.

# CHAPTER V

## COMPOSITION OF ANIMALS

**Combustible Matter.**—Animals are often destroyed by fire; they possess, therefore, combustible materials. These consist largely of the nitrogenous substances, and the fats, both of which are present in the frame, tissue and other organic portions of the body. In the skeleton, or frame, three classes of substances are formed—protein, gelati-




CHEAPEST GAINS ARE MADE WITH YOUNG ANIMALS

As animals advance in age the cost of food for maintenance and increase advances also. Compare the four classes of cattle as sketched above.

nous matter, and horny matter. Of first importance is the protein, which forms the greater part of the muscular tissue, the various organs, the material of which the nervous system is made, and the major portion of the solid matter of blood. Connective tissue, the combustible part of the cartilage and bone, and the skin, are formed of the gelatinous matter. Horn, hair, wool, and feathers constitute the horny matter. The animal juices are of a nitrogenous origin also. The fats contain no nitrogen, but are combustible and are either of a hard or a fluid nature.

**Incombustible Matter.**—The bones contain the largest part of the incombustible constituents. Here are found calcium phosphate, calcium carbonate and magnesium phosphate in greatest abundance. Potassium phosphate heads the list in the tissues. These mineral substances constitute from three to five per cent of the live weight of the animal.

**Water.**—More than half of the entire weight of the animal is water. It is to be found in all parts of the body and is as essential for the development of solid tissue as any of the other ingredients. Young and growing animals, like young and growing plants, contain the highest percentage of water. As the animal matures the proportion of water diminishes until it reaches about one-half of the total weight.

**Range of Variation of Materials.**—The amounts of water, nitrogenous matter, fat, and the mineral constituents present in a large number of animals have been determined at Rothamsted Station in England. The table following shows the range of variation of the various constituents and for different animals.

PERCENTAGE COMPOSITION OF WHOLE ANIMAL (WARRINGTON)

| Constituent | Fat Calf | Half Fat Ox | Fat Ox | Fat Lamb | Fat Sheep | Store Pig | Fat Pig |
|---|---|---|---|---|---|---|---|
| Water .. | 65.1 | 56.0 | 48.4 | 52.2 | 46.1 | 58.1 | 43.0 |
| Protein . | 15.7 | 18.1 | 15.4 | 13.5 | 13.0 | 14.5 | 11.4 |
| Fat .... | 15.3 | 20.8 | 32.0 | 31.1 | 37.9 | 24.6 | 43.9 |
| Ash .... | 3.9 | 5.1 | 4.2 | 3.2 | 3.0 | 2.8 | 1.7 |

The smallest amounts of both ash and protein are found in the pig, the largest in the ox. Fat is

found in greatest quantity in the pig and least in the calf. The ingredient in largest quantity is water.

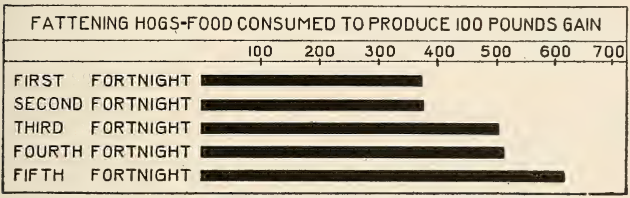
**Principal Ash Constituents.**—It is of interest, and worth while also, to know what quantities of nitrogen, phosphoric acid and potash are to be found in various animals and their products. This information is of value in determining the quantity of each removed from the farm when an animal is sold or its products sent to market. In the following table these data are given.

NITROGEN, PHOSPHORIC ACID AND POTASH IN 1,000 POUNDS (WARRINGTON)

| Animal | Nitrogen | Phosphoric acid | Potash |
|---|---|---|---|
| Fat Calf ............ | 24.6 | 15.4 | 2.1 |
| Fat Ox ............. | 23.3 | 15.5 | 1.8 |
| Fat Lamb .......... | 19.7 | 11.3 | 1.7 |
| Fat Sheep .......... | 19.8 | 10.4 | 1.5 |
| Store Pig ........... | 22.1 | 10.7 | 2.0 |
| Fat Pig ............ | 17.7 | 6.5 | 1.4 |
| Washed Wool ..... | 94.4 | 1.8 | 1.9 |
| Milk ................ | 5.8 | 2.0 | 1.7 |
| Skim Milk ......... | 5.0 | 2.1 | 2.0 |

In the fat calf and the fat ox the largest amount of these three important fertilizing elements is removed, and in the fat pig the least. Hog raising, therefore, is less hard on the land than beef production. Dairying is more favorable even than pork. If we assume a cow produces 5,000 pounds of milk during a lacteal period and this milk is sold to the city, the loss to the land will be 29 pounds of nitrogen, 10 pounds of phosphoric acid and 8.5 pounds of potash. Rating the nitrogen at 16 cents a pound,

the phosphoric acid at 5 cents and potash at 5 cents, the total money loss will be $5.57. The milk, if sold at 4 cents a quart, would bring $100. Considering the large amount of feed furnished and the large amount of manure resulting therefrom, the loss in plant food is small. If, instead of selling milk, butter is sold, the loss of these three elements will be insignificant.




Food Consumed During Fattening Period

During a ten-week fattening period with hogs the food consumption increases more than 50 per cent to produce 100 pounds of increase. There is a limit to which hogs can be profitably fed.

**Percentage of Increase in Fattening.**—When animals are fattened for market an increase of all constituents is noticed. This is shown in the table below.

INCREASE DURING FATTENING STAGE (WARRINGTON)

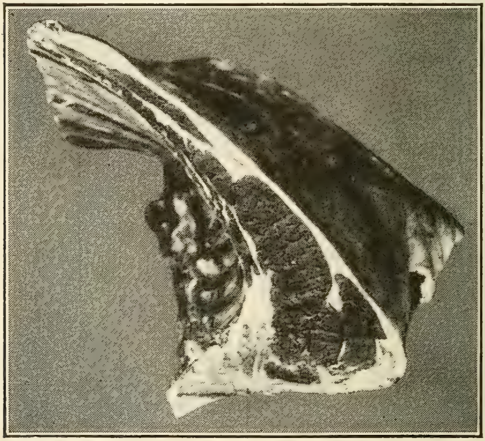
| | Water | Protein | Fat | Ash |
|---|---|---|---|---|
| Pigs ............ | 28.6 | 7.8 | 63.1 | 0.5 |
| Beeves .......... | 24.6 | 7.7 | 66.2 | 1.5 |
| Sheep ........... | 22.0 | 7.2 | 68.8 | 2.0 |

The sheep, during the fattening period, stores up fully four times as much ash as the pig. The significant thing brought out in this table is the fact

that the protein increase is very similar in the three classes, and that the fat increase ranges between eight and nine times the quantity of the protein.

**Group Constituents.**—The substances of the animal's body may be grouped under four heads:

1. Water.
2. Ash or mineral matter.
3. Protein.
4. Fat.



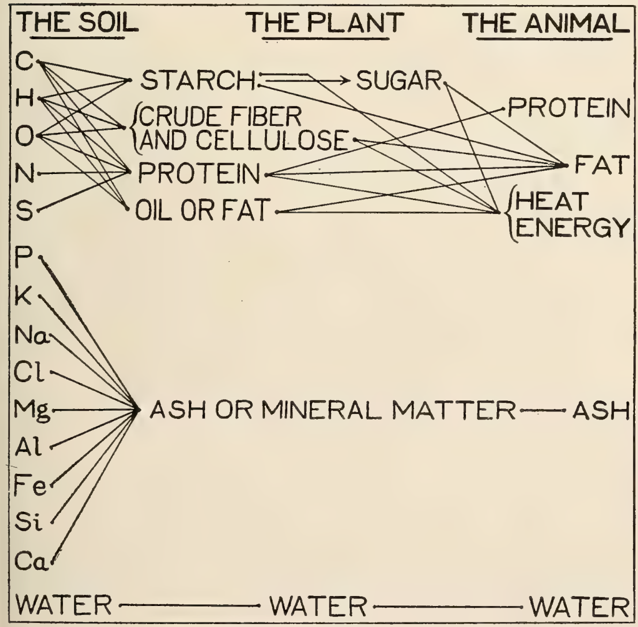
WHAT AN ANIMAL CONTAINS

Protein, the dark red substance; fat, the white strips; bone or mineral matter; and water, comprise the distinct groups of substances that form the animal body.

This grouping differs little from that of plants. Since starch, the vegetable gums, sugar, cellulose, etc., are derived from the same elements and have the same fuel value when assimilated by the animal, they can be classed as carbohydrates. The carbo-

hydrates are formed of carbon, hydrogen, and oxygen; the last two elements are in the proportion to form water, hence the name. When all the plant constituents are grouped together the five divisions are as follows:

1. Water.
2. Ash.
3. Protein.
4. Fat.
5. Carbohydrates.




CYCLE OF LIFE

From the plant is fed the animal; from the animal is sustained the soil; from the soil and air is nourished the plant.

From the standpoint of composition the only difference between plants and animals is in the fact that the former contain carbohydrates and the latter do not.

**What These Compounds Do.**—Protein is the "muscle maker" of the body; fat and carbohydrates, the "heat and energy producers." The protein of the plant is changed into the protein of the animal. In the animal this constituent comprises the muscular tissue, blood, hair and nerves, the internal organs, skin, etc. In addition the protein is used in the repair work of the body. Every beat of the heart, every circuit of the blood, and every move of a muscle, demands that some protein substance be used up. To keep the animal machine in good working order these parts must be kept in repair. Hence, protein at all times must replace the broken parts with a new supply. If this supply satisfies the waste, the weight of the animal will remain unchanged. When the supply is liberal, or exceeds the demands of the system, material may be stored in the body as flesh or fat, and the animal will gain in weight.

Food is needed to keep animals warm. As wood gives off heat when burned in the stove, so food consumed in the body furnishes heat. This consumption of fuel food is so well regulated in a healthy animal that the temperature remains at the same point at all times. Carbohydrates and fats are mainly the sources of the heat supply. These same ingredients are used for the production of fat

in the body and of muscular energy; yet protein may also be used.

**Protein Food** furnishes in the animal body:

1. Protein
   Blood,
   Brain and nerves,
   Internal organs and skin,
   Flesh, etc.
2. Heat
3. Fat
4. Energy

**Fat of Food** furnishes in the animal body:

1. Heat
2. Fat
3. Energy

**Carbohydrates of Food** furnish in the animal body:

1. Heat
2. Fat
3. Energy

## CHAPTER VI

# FOOD NUTRIENTS

**Nutrients Defined.**—Any substance absorbed into the system in the process of digestion or that contributes to the support of animal life is a *nutrient*. Hence, the albumen of an egg, the starch of a potato,

COWPEAS A RICH FOOD

Much nutrition is obtained from cowpeas and other leguminous crops. These are relatively rich in protein, and hence should have a place in every system of farming.

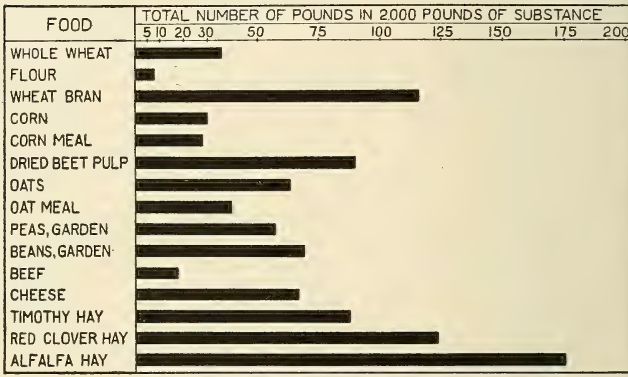
the salts of an apple, the ash of wheat bran, the fiber of pasture grass, are all nutrients and as such promote the well-being of animals which can grow, do work, give milk or lay on fat or flesh.

**Most Feeding Stuffs are Unbalanced.**—If every food were wholly digestible and the digestible protein, digestible carbohydrates and digestible fats were united in every feeding stuff in just the right proportion to meet the needs of the particular animal, the feeding of farm animals would be a simple problem. But plants vary in composition; their food constituents are neither all nor yet equally digestible; some are much concentrated in form, while others place their food nutrients in large bulk. Because of these differences in the nature of feeding stuffs it is necessary to resort to wide variety and to blend or mix the provender that the varying needs of the various classes under continuous change of method of feeding or of age or of purpose may be met. This gives rise to the compounding of rations for each special class of live stock.

But few single feeding stuffs furnish the required quantities of protein, carbohydrates and fat; the most economical and best results are secured when two or more are combined. By such a combination, if one feed is lacking in protein, for instance, this deficiency may be met in the ration through the selection of another substance possessing the protein element in unusual abundance. In this manner the shortage of the one is balanced by the abundance of the other.

**Digestibility Defined.**—Every feeding stuff contains protein, carbohydrates, fat, ash and water. Of each of these there is a distinct proportion absorbed, and the remainder is rejected and excreted in the feces. The proportion which represents the quan-

tity absorbed is spoken of as the amount *digested* or absorbed into the system. *Digestibility* refers to the true food value of any nutrient. Every food, therefore, regardless of the balance of its proximate principles, contains both digestible and indigestible matter. To know the proportion of each part is




MINERAL MATTER IN SOME COMMON FOODS

The total number of pounds of mineral matter in a ton of certain substance is here shown. Notice how small is the quantity in a ton of wheat flour. Wheat bran, on the other hand, is abundantly supplied. In our methods of manufacture farm animals profit at the expense of the human family.

necessary if the feeder is to make use of his feeds to the best advantage.

**How Digestibility of a Food Is Determined.**—The general method of investigation to obtain the digestibility of the various constituents of a feeding stuff has been to supply an animal with weighed quantities of food the composition of which has been ascertained by chemical analysis. Within the period during which such an experiment is being con-

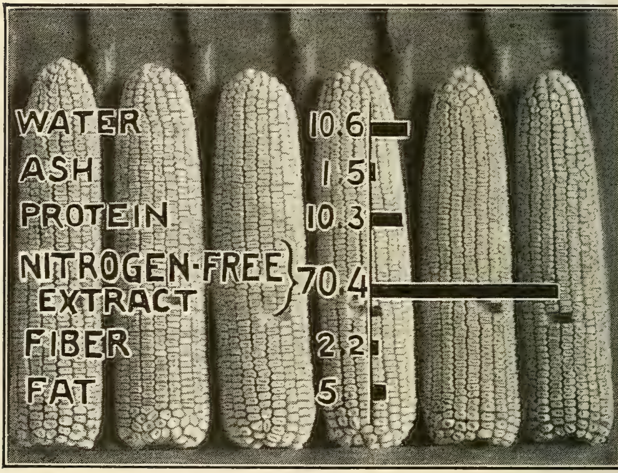
ducted, the solid excrements are collected, weighed and analyzed by the same chemical methods applied previously to the food. By this plan the amount of each constituent of the food which has passed through the animal unabsorbed is determined. It is a simple matter now to subtract this quantity from the amount found to have been present in the food originally and to obtain the difference, which is the amount digested and absorbed.

**First Step Is to Obtain Composition.**—Chemists have analyzed all the important feeding stuffs. Slight variation is noted, which is due largely to difference of variety, soil, climate, season, fertilization and culture. Based on averages, the resulting figures of composition are sufficiently accurate for all purposes of ration building. In the table following a few common feeding stuffs are included for assistance in determining the real nutritive value of each constituent.

COMPOSITION OF SOME COMMON FEEDING STUFFS

| Feeding stuffs | In 100 pounds of fresh substance | | | |
|---|---|---|---|---|
| | Protein | Crude fiber | Nitrogen-free extract | Fat |
| Corn stover—field cured .... | 3.8 | 19.7 | 31.5 | 1.1 |
| Red clover hay .. | 12.3 | 24.8 | 38.1 | 3.3 |
| Timothy hay .... | 5.9 | 29.0 | 45.0 | 2.5 |
| Cottonseed hulls.. | 4.2 | 46.3 | 33.4 | 2.2 |
| Corn—dent ...... | 10.3 | 2.2 | 70.4 | 5.0 |
| Wheat bran ..... | 15.7 | 9.0 | 53.9 | 4.0 |
| Cottonseed meal.. | 45.3 | 6.3 | 24.6 | 10.1 |
| Gluten feed ..... | 25.0 | 6.8 | 53.5 | 3.5 |

By this table not only a wide difference in the quantity of each constituent of each feeding stuff is noticed, but also that this obtains in all feeds, with no regularity of quantity for any constituent. The amount of protein varies from 3.8 pounds in corn stover to 45.3 pounds in cottonseed meal. In respect




WHAT FIELD CORN CONTAINS

When corn is analyzed nitrogen-free extract, or starch, is found to be present in the largest quantity. The amount of protein is not large and the ash supply is small. Corn as an exclusive food would insufficiently supply the mineral elements, and there would be too little protein in proportion to the starch and fat.

to crude fiber the amount ranges from 2.2 pounds in corn to 46.3 pounds in cottonseed hulls. The greatest variation is with the nitrogen-free extract; it runs from 24.6 pounds in cottonseed meal to 70.4 pounds in corn. Much difference is observed also in the fat; 1.1 pound is present in corn stover, but this advances to ten times that in the cotton meal.

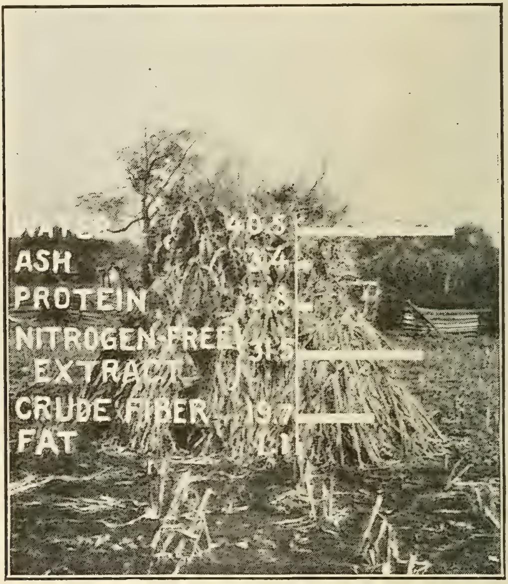
**Coefficient of Digestibility.**—In the composition of feeding stuffs, both the digested and unabsorbed materials are included. The absorbed matter only is of importance as food. The data obtained through the digestion trials make known the percentage of each nutrient digested. Such figures express the *digestion coefficient* for each constituent of the food consumed. In the table following are given the figures representing the coefficients of digestibility for each constituent of each feeding stuff previously given.

DIGESTION COEFFICIENTS OF SOME COMMON FEEDING STUFFS

| Feeding stuffs | Percentage digestible | | | |
|---|---|---|---|---|
| | Protein | Crude fiber | Nitrogen-free extract | Fat |
| Corn stover ....... | 45 | 67 | 61 | 62 |
| Red clover hay.... | 55 | 46 | 64 | 53 |
| Timothy hay ...... | 48 | 52 | 63 | 60 |
| Cottonseed hulls .. | 6 | 47 | 34 | 79 |
| Corn .............. | 76 | 58 | 93 | 86 |
| Wheat bran ....... | 77 | 41 | 71 | 63 |
| Cottonseed meal .. | 83 | 35 | 78 | 94 |
| Gluten feed ....... | 85 | 76 | 89 | 82 |

A marked variation is shown in this table. None of the constituents are equally well digested. In few instances are more than three-fourths of any one substance absorbed into the system. With cottonseed hulls but 6 per cent of the protein is digested, but a large amount of the fat—79 per cent—is absorbed.

**Digestible Nutrients.**—With both the composition and the digestible percentage known, it is a comparatively simple matter to determine the digestible quantity of each constituent. This is done by multi-




WHAT CORN STOVER CONTAINS

Corn stover contains more ash, water and fibre, and less protein, starch and fat than corn. Ear corn contains the same food ingredients, but these are more valuable because less fibrous and more concentrated. The real worth-while nutrients are protein, starch, and fat.

plying the figures representing the total amount of each constituent by the coefficient of digestibility, the resulting product being the quantity digested. For example, corn stover contains 3.8 pounds of protein, 19.7 pounds of crude fiber, 31.5 pounds of nitro-

gen-free extract and 1.1 pounds of fat. By multiplying these amounts by the figures representing the digestibility for each constituent respectively, the amount of each *digestible nutrient* will be obtained. This is done as follows:

| Constituent | Composition | | Digestible Coefficient | | Digestible Nutrient |
|---|---|---|---|---|---|
| Protein .................... | 3.8 | x | 45 | = | 1.7 |
| Crude Fiber .............. | 19.7 | x | 67 | = | 13.2 |
| Nitrogen-free extract ..... | 31.5 | x | 61 | = | 19.2 |
| Fat ........................ | 1.1 | x | 62 | = | 0.7 |

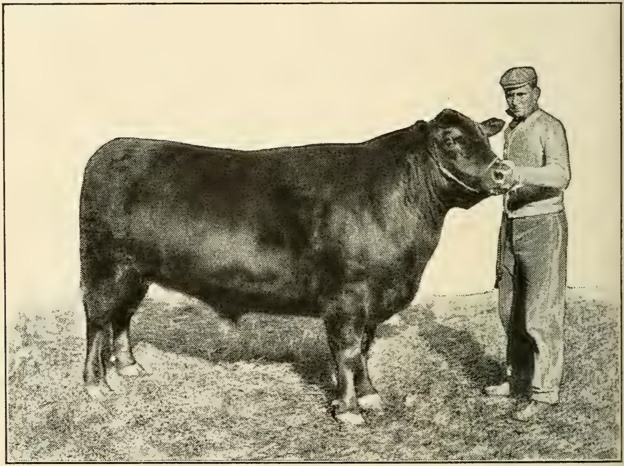
The total digestible nutrients may be determined in this manner for each feeding stuff. Crude fiber and nitrogen-free extract, being used for the same purpose after absorption, may be included as a single group. They stand for the same thing, and from now on will be grouped under the term carbohydrates. In the table below the feeding stuffs previously mentioned are listed and the total digestible nutrients of each are shown.

DIGESTIBLE NUTRIENTS IN SOME COMMON FEEDING STUFFS

| Feeding stuffs | Digestible nutrients in 100 pounds | | |
|---|---|---|---|
| | Protein | Carbohydrates | Fat |
| Corn stover ....... | 1.7 | 32.4 | 0.7 |
| Red clover hay .... | 6.8 | 35.8 | 1.7 |
| Timothy hay ... .. | 2.8 | 43.4 | 1.5 |
| Cottonseed hulls . | .3 | 33.1 | 1.7 |
| Corn ........ ... | 7.8 | 66.7 | 4.3 |
| Wheat bran ........ | 12.1 | 41.9 | 2.5 |
| Cottonseed meal .. | 37.6 | 20.7 | 9.5 |
| Gluten feed ...... | 21.3 | 51.8 | 2.9 |

**Correct Rations are Based on Digestibility.**— From the data here given the importance of basing

all feeding rations on the digestible matter rather than on the total composition is clearly seen. Only a part of the food taken into the stomach is assimilated—just a part; sometimes 90 per cent, sometimes 75 per cent, some times 50 per cent and in the case of some foods as little as 25 per cent is digestible. Hence, in every feed there is a part lost and



HE HAD A GOOD RATION

This is a picture of the champion grade steer at the 1909 International live stock show. He was fed a variety of food, and with great care and thought.

wasted to the animal; therefore, this serves no contribution to the nutriment of the body.

Nor can one constituent be used wholly to take the place of any other. Since protein contains nitrogen and sulphur in addition to carbon, hydrogen and oxygen, it is evident that neither the carbohydrates nor the fats which contain carbon, hydrogen and

oxygen only can be substituted for protein. Just as the phosphorus or potassium of a fertilizer cannot replace nitrogen, so the carbohydrates or the fats cannot replace the protein of a food. While it is true that protein may be substituted for the carbohydrates and fats, it is to a limited extent, and only for a limited time. Even though the well-being of the animal would permit of this substitution the added expense would be against the practice.

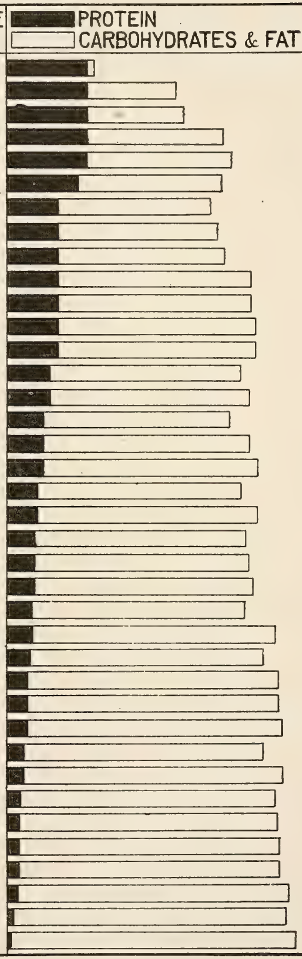
## CHAPTER VII

## SOME SCIENTIFIC TERMS IN FEEDING

**The Animal as a Machine.**—Considered as a machine, the animal body needs two classes of food: one, to furnish the materials by which the machine may be constructed and kept in repair; and a second, or sustaining reserve, to develop heat to keep the body warm and to supply energy for the production of internal and external work. Water, ash and protein are the essential building materials and the fats and carbohydrates the primary fuel substances. This distinction gives rise to the grouping of feeding stuffs as being either of a building or fuel nature. All individual foods contain both, but in varying proportions; some are heavy carriers of the first, others of the second, and still others within these two extremes. Food values, therefore, are somewhat dependent upon the manner in which they are classified; this, of course, being consistent with the nature of their digestible nutrients.

**Nutritive Ratio.**—A point of some importance in determining the suitability of a feeding stuff as an article of diet is the proportion between the digestible protein and the digestible non-protein organic constituents. This relation is most conveniently termed the *nutritive ratio* of the food. Simply defined, this term means the ratio which exists between the amount of digestible protein to the combined digestible carbohydrates and fat. It is

| FEEDING STUFF | NUTRITIVE RATIO |
|---|---|
| DRIED BLOOD | 1: 0.1 |
| TANKAGE | 1: 1.1 |
| COTTON SEED MEAL | 1: 1.2 |
| LINSEED MEAL | 1: 1.7 |
| SOY BEANS | 1: 1.8 |
| SKIM MILK | 1: 2. |
| GLUTEN FEED | 1: 3. |
| COW PEAS | 1: 3.1 |
| DRIED BREWERS' GRAINS | 1: 3.2 |
| COWS MILK | 1: 3.7 |
| WHEAT BRAN | 1: 3.7 |
| ALFALFA | 1: 3.8 |
| COW PEA HAY | 1: 3.8 |
| PASTURE GRASS | 1: 4.5 |
| WHEAT MIDDLINGS | 1: 4.7 |
| MANGLES | 1: 5.1 |
| RAPE | 1: 5.6 |
| RED CLOVER HAY | 1: 5.8 |
| OATS | 1: 6.2 |
| BUCKWHEAT | 1: 6.9 |
| RYE | 1: 7.1 |
| WHEAT | 1: 7.2 |
| TURNIPS | 1: 7.7 |
| KAFIR CORN | 1: 8.1 |
| BLUE GRASS | 1: 8.6 |
| CORN | 1: 9.7 |
| BEET PULP | 1: 12. |
| MILLET HAY | 1: 12. |
| PRAIRIE HAY | 1: 12.2 |
| CORN SILAGE | 1: 14. |
| CORN & COB MEAL | 1: 15.1 |
| TIMOTHY HAY | 1: 16.6 |
| POTATO | 1: 18.3 |
| CORN STOVER | 1: 20. |
| KAFIR CORN STOVER | 1: 20. |
| SORGUM HAY | 1: 22. |
| OAT STRAW | 1: 33.6 |
| WHEAT STRAW | 1: 93. |




Nutritive Ratio of Some Common Feeding Stuffs

obtained as follows: The fat is reduced to its carbohydrate equivalent and added to the digestible carbohydrates. The sum of the two, representing the non-protein, is then divided by the figure or figures representing the quantity of protein. The resulting figure is the second factor, which means that for each pound of protein in the feed or ration there are so many pounds of non-protein or carbohydrates.

**Reducing Fat to Carbohydrates.**—The non-protein constituents of a feed—starch, fiber, fats, etc.—are used to develop heat, energy and fat in the animal body. Their efficiency for this purpose has been ascertained by numerous experiments, which show that a pound of fat will develop as much heat energy as 2.3 pounds of starch. Hence, this more concentrated energy must be taken in consideration in combining the carbohydrates and fat as a single unit group if a definite, accurate value is to be obtained with reference to any feeding stuff. In all calculations from now on this higher efficiency of fat will be given its proper weight.

**Determining the Nutritive Ratio.**—In a previous table the digestible nutrients in 100 pounds of corn were shown to be as follows: Protein 7.8 pounds, carbohydrates 66.8 pounds and fat 4.3 pounds. The fat first is reduced to its carbohydrate equivalent by multiplying the number of pounds representing it by the authoritatively taken factor 2.3; which being done, shows that 4.3 pounds of fat equal 9.9 pounds of the carbohydrates in producing heat and energy. The fat, now having been reduced to a carbohydrate basis, can be added to 66.8, the amount of carbo-

hydrates in corn, which gives 76.7 pounds of total carbohydrates. This sum divided by the number representing the quantity of protein, which in the case of corn is 7.8 pounds, gives the final factor of the ratio, or 9.8.

In the form of proportion the stages are as follows:

(1) The amount of protein is to the amount of the carbohydrates as 1 is to the factor to be determined.

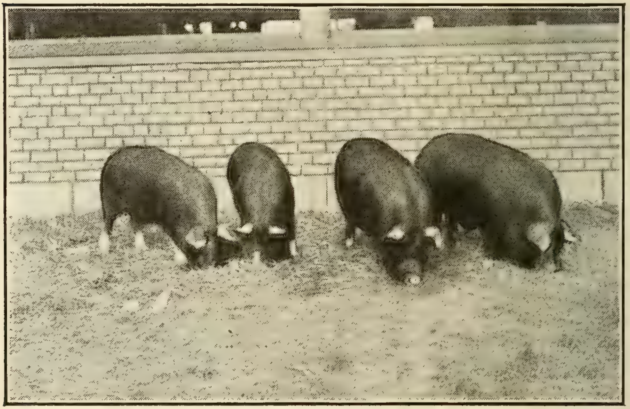
| | | | |
|---|---|---|---|
| (2) Protein | : Carbohydrates | : : 1 | : x |
| (3) 7.8 | : (66.8 + 9.9) | : : 1 | : x |
| (4) 7.8 | : 76.7 | : : 1 | : 9.8 |

The nutritive ratio of corn is therefore 1 to 9.8, which means that in this feeding stuff for every pound of digestible protein there are 9.8 pounds of digestible carbohydrates and fat equivalent.

**Wide or Narrow Nutritive Ratio.**—A wide difference exists among feeds as to the proportion of protein which they contain. The oil meals and the legumes, especially their seeds, are rich in protein, roots and straw very poor, while cereal grain and their products occupy a middle place. These differences give rise to the terms *wide* and *narrow nutritive ratios* which apply both to single feeds and rations. A feed or a ration has a "narrow" nutritive ratio when the digestible protein contained in it is high in comparison to the carbohydrates and fat, and "wide" when the reverse to this; that is, little protein and much of the carbohydrates and fat.

**Balanced Ration.**—Since all feeding stuffs, with the possible exception of pasture grass, are unfit as single food substances, they naturally fall in a class

as being either wide or narrow. If two or more are combined in the proper proportions to furnish all the digestible nutrients, with no excess or shortage of any nutrient, but in just the quantity needed by a certain class of animals fed for a distinct purpose, the combination is then satisfactory, and does provide a *balanced ration.*



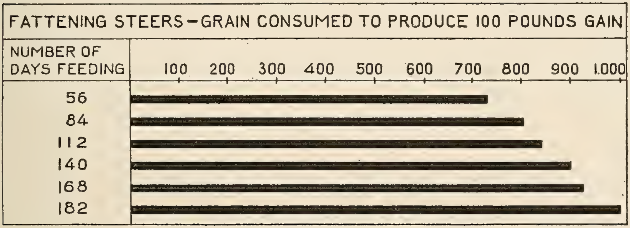
BALANCING THE RATION IMPROVES IT

The two larger pigs at the right have been fed corn and tankage, while the two smaller ones at the left have been fed corn only. This shows why a balanced ration is worth while.

**Feeding Standards.**—For many years investigators have been conducting feeding tests to learn the amount of digestible protein, carbohydrates and fat best for farm animals under average conditions. They have studied the results of various foods and varying amounts in thousands of animals. The results are embodied in what are called *feeding standards.* These tell the proper amounts of the nutri-

ents, or one day's food, for an animal of a certain weight under ordinary conditions.

The subject is complicated in so many ways that it is out of the question to say with great definiteness in the present light of feeding knowledge just what amount of each nutrient to give so the very best results may be obtained for the average animal




WHEN THE FEEDING PERIOD IS EXTENDED

When fattening steers were fed for 56 days slightly over 700 pounds of food were consumed for each 100 pounds of gain. When the feeding period was lengthened to 182 days over a thousand pounds of grain was necessary to give 100 pounds of increase.

under the average methods of feeding. The early standards proposed by German experimenters have been somewhat modified by other investigators, but so far, even though other attempts have been made to simplify these standards, the original Wolff-Lehmann feeding standards are still the most popular guides in all studies of ration making.

**Maintenance Standard.**—For one thing, these early teachers stated that less nutrients are necessary for animals doing no work, or giving no milk, or not fed for fattening purposes, than for animals actually so engaged. This has given rise to a standard for maintenance when the animal is at rest in

the stall. They showed, also, that a dairy cow giving little or no milk does not require nearly as large a quantity of food as one in full flow of milk. Of course, every farmer knows this; but these investigators prepared a guide giving the quantity of digestible protein, carbohydrates and fat so as to meet the *maintenance needs* of the dry cow.

The dry cow does need daily a certain amount of each of the food nutrients. She must keep her body warm, maintain the regular blood supply, repair the broken-down tissues and meet all the requirements of life and health. These things are obtained from the food. If more food is provided than necessary to meet these daily demands, the animal will increase in weight. If too little food is given, then the reverse will happen, the animal will lose in weight, and, as popularly expressed, will become thin in flesh, or poor. Working from this point, these nutrition investigators carefully prepared standards for cows giving various quantities of milk, for steers at different stages of fattening, for horses doing little or much work, and for hogs and sheep at their various periods of growth and fattening.

**Standards for Farm Animals.**—These feeding standards as guides indicate for feeders what amount of each nutrient is required in the body, not only for maintenance and support, but also for milk or beef, wool or mutton, and labor. A different standard is provided for different animals and consistent with the purposes for which the animals are fed. A cow giving little milk, according to the standard, is to be given smaller quantities of food

than another in heavy milk flow. Likewise rations for beeves differ considerably from those for horses or pigs. These feeding standards, though easily understood, are still very complicated, but they clearly show that the practice of feeding is not only an interesting art, but one that calls for much skill and training also.

WOLFF-LEHMANN FEEDING STANDARDS

| Daily allotment on basis 1,000 pounds live weight | | | | |
|---|---|---|---|---|
| | | Digestible nutrients in pounds | | |
| | Dry matter | Protein | Carbo-hydrates | Fat |
| Milk cows when giving daily | | | | |
| 11 pounds of milk ... | 25 | 1.6 | 10.0 | .3 |
| 22 pounds of milk ... | 29 | 2.5 | 13.0 | .5 |
| 27.5 pounds of milk ... | 32 | 3.3 | 13.0 | .8 |
| Fattening cattle | | | | |
| First period ......... | 30 | 2.5 | 15.0 | .5 |
| Second period ....... | 30 | 3.0 | 14.5 | .7 |
| Third period ........ | 26 | 2.7 | 15.0 | .7 |
| Sheep | | | | |
| Coarse wool ........ | 20 | 1.2 | 10.5 | .2 |
| Fine wool ........... | 23 | 1.5 | 12.0 | .3 |
| Ewes with lambs .... | 25 | 2.9 | 15.0 | .5 |
| Fattening sheep | | | | |
| First period ........ | 30 | 3.0 | 15.0 | .5 |
| Second period ........ | 28 | 3.5 | 14.5 | .6 |
| Horses | | | | |
| Light work .......... | 20 | 1.5 | 9.5 | .4 |
| Medium work ....... | 24 | 2.0 | 11.0 | .6 |
| Heavy work ......... | 26 | 2.5 | 13.3 | .8 |
| Brood sows ........... | 22 | 2.5 | 15.5 | .4 |
| Fattening hogs | | | | |
| First period ......... | 36 | 4.5 | 25.0 | .7 |
| Second period ....... | 32 | 4.0 | 24.0 | .5 |
| Third period ......... | 35 | 2.7 | 18.0 | .4 |

These standards are based on 1,000 pounds live weight. For animals weighing less, as sheep and

swine, the quantity prescribed would be proportionately decreased. A sheep, for instance, weighing 100 pounds would be fed one-tenth the quantity called for in the standard. An animal weighing more than 1,000 pounds would require a proportionate increase.

**Feeding Standard Only a Guide.**—No one should rely absolutely on the feeding standard as his sole aid in feeding any class of animals. Standards are to be taken as guides only and are to be varied or modified as circumstances require. In fattening farm stock it is clearly the best sense to supply the largest amount of food that the stock fed can make profitable use of. In feeding dairy cows, so long as hay, fodder, and silage are home-raised and abundant, the cows may safely be given as much as they can be tempted to eat, provided of course, the concentrated feeds are not denied proper places in the ration. Those responding in heavy milk yields are entitled to the largest amounts of the concentrates, while those that are milking little will not require much, if any, food of a grain or concentrate nature.

Not only the object sought but the food also will govern. So does the season of the year exert its influence. Then too, and not the least either, the size of the animal affects the food consumption in respect to the general results. A great part of the demand for food is determined by the surface of the animal rather than by its weight. With these circumstances in mind as examples of various factors that must be considered, the feeding standard may well be used as a starting point in the practical feeding of the farm live stock.

## CHAPTER VIII

## THE COMPUTATION OF RATIONS

**An Animal Uses Food** for five distinct purposes:

1. To replace the waste from all parts of the body.
2. To produce heat to keep the body warm.
3. To produce energy so that work may be done.
4. To provide the building materials for larger growth or increase in muscle, fat, flesh, and bone.
5. To have materials in reserve for the formation of milk, wool, etc.

These five purposes develop after the food is absorbed, and originate from the digestible nutrients expressed in terms of protein, carbohydrates and fat. To provide these nutrients in the quantity and proportions that they should be fed, so as to satisfy one or more of the five ends of feeding, makes necessary the selection and compounding of rations.

**Three Kinds of Rations.**—As an example of how a mixture of feeding stuffs may be devised so as to yield the requisite amounts of the protein and energy nutrients and at the same time be neither too bulky nor too concentrated, one of the following courses is generally open. Suppose a ration is wanted for a herd of dairy cows. What class of food shall be placed before the animals? In answer to this question it is possible to furnish any one of

three kinds of rations. One of these might consist of the roughage food raised on the farm like straw, corn stover, the usual farm hays, and a small feed of ear corn; on the other hand, a ration might be furnished consisting largely of grain feed or concen-

TIMOTHY NOT A BALANCED FOOD

Although one of the most popular hay crops, timothy contains a small amount of protein. It is an excellent horse food but not as good for dairy cows as clover, alfalfa, or cowpeas.

trates, with a small allowance of some cheap roughage for feeding.

Neither of these is uncommon. On many farms the cows are given the very feeds here mentioned. In villages, and in herds near large cities, other cows are fed largely the by-products of certain manufac-

turing enterprises or on chop feeds and other grain materials that may be purchased often as cheaply as hay. The result is, in neither instance are the cows fed as they ought to be. The cow in the country gets too little protein and too much carbohydrates and fat; the village cow too much of protein and too little of the carbohydrates and fat; and

Mixing Their Own Ration

These cows have the run of a large area in which several kinds of grasses flourish. Rape is growing in the foreground.

the best results are not obtained in either case. The country cow loses in weight; she gets poor; she is forced to take from her own body much protein stored in flesh to use for milk and tissue repair. The village cow may or may not thin down, but the necessity of using the protein in the food for meeting all the functions of the nutrients acts to her disadvantage and she is never able to be at her best.

**Mixed Foods.**—Best results are always secured when these two methods are merged: when the country cow is given concentrates in addition to the farm-raised roughages, and the village cow gets hay and stover in addition to the feed-store mill feeds. It is not enough to secure grain as concentrates for the country cow either; the selection must be made on the basis of the composition; and, since the country cow's ration is already out of proportion because of the excess of carbohydrates and fat, it would not help the matter any by a purchase of a grain food also low in protein.

In practice many feeders buy corn meal as a dairy concentrate; instead of improving the ration this makes things worse, because corn meal added to the grass hay, corn stover, straw ration only increases the cost without supplying any appreciable increase of protein. The way out of this difficulty is to study the available concentrates and select one or more that contains protein, and not starch and fat, in greatest abundance.

**How a Ration is Made.**—Rations are usually computed on the basis of 1,000 pounds live weight for the animals. If the animals weigh more, a proportionate increase of food is allotted; if less, a proportionate decrease.

The first step in computing a ration is to consider the feeding standard for the class of animals to be fed. If it is assumed that a ration is wanted for a dairy cow giving 22 pounds of milk daily, the table of standards is to be consulted. For dairy cows giving 22 pounds of milk the standard calls for 29

pounds of dry matter, 2.5 pounds of digestible protein, 13 pounds of digestible carbohydrates, and 0.5 pounds of digestible fat. Assuming that corn stover, corn silage and clover hay are the most available, we will use such quantities of each as have been found in practice to be fairly representative of the available supply on average farms and about what an animal will eat up clean without tiring her appetite.

As a starting point, we will use 10 pounds of corn stover, 15 pounds of clover hay and 30 pounds of corn silage. The averages for digestible nutrients in these feeds are the following:

| Feeding stuffs | Dry matter | Digestible nutrients in 100 pounds | | |
|---|---|---|---|---|
| | | Protein | Carbo-hydrates | Fat |
| Corn stover ........ | 59.5 | 1.4 | 31.2 | 0.7 |
| Corn silage ......... | 20.9 | 0.9 | 12.6 | .6 |
| Clover hay .......... | 84.7 | 7.1 | 37.8 | 1.8 |

The second step in the computation is to calculate the pounds of digestible nutrients in the quantities of each of these feeding stuffs. It is clear, for instance, that 10 pounds of corn stover will contain just one-tenth as much protein, carbohydrates and fat as 100 pounds. If each of these factors be divided by 100 and multiplied by 10, we shall have the amounts of each constituent that 10 pounds of corn stover will furnish the animal.

The 100 pounds of corn stover contain:

59.5 pounds of dry matter,
1.4 pounds of protein,
31.2 pounds of carbohydrates,
0.7 pounds of fat.

If 100 pounds of corn stover contain these quantities of digestible nutrients, then 1 pound contains just one one-hundredth as much, or the following quantities:

.595 pounds of dry matter,
.014 pounds of protein,
.324 pounds of carbohydrates,
007 pounds of fat.

Ten pounds, of course, will contain ten times the quantity of 1 pound, or the following:

5.95 pounds of dry matter,
.14 pounds of protein,
3.24 pounds of carbohydrates,
.07 pounds of fat.

The digestible nutrients in 30 pounds of corn silage are ascertained in the same manner:

| | In 100 pounds | | In 1 pound | | In 30 pounds |
|---|---|---|---|---|---|
| Dry matter ............... | 20.9 | ÷ 100 = | .209 | x 30 = | 6.27 |
| Protein ..................... | 0.9 | ÷ 100 = | .009 | x 30 = | .27 |
| Carbohydrates ............ | 12.6 | ÷ 100 = | .126 | x 30 = | 3.78 |
| Fat .......................... | 0.6 | ÷ 100 = | .006 | x 30 = | .18 |

Making the same computation for each constituent in clover hay, we have the following:

| | In 100 pounds | | In 1 pound | | In 15 pounds |
|---|---|---|---|---|---|
| Dry matter .............. | 84.7 | ÷ 100 = | .847 | x 15 = | 12.70 |
| Protein .................... | 7.1 | ÷ 100 = | .071 | x 15 = | 1.06 |
| Carbohydrates ........... | 37.8 | ÷ 100 = | .378 | x 15 = | 5.67 |
| Fat ......................... | 1.8 | ÷ 100 = | .18 | x 15 = | .27 |

If we arrange these figures in a table and add the nutrients together, we shall have a statement of the quantity of each constituent supplied in these feeds, and will be in a position to compare with the standard to know what nutrients are insufficiently provided. This is done as below:

| Feeding stuffs | Dry matter | Digestible nutrients | | |
|---|---|---|---|---|
| | | Protein | Carbo-hydrates | Fat |
| 10 lbs corn stover.. | 5.95 | .14 | 3.24 | .07 |
| 30 lbs corn silage.. | 6.27 | .27 | 3.78 | .18 |
| 15 lbs clover hay .. | 12.70 | 1.06 | 5.67 | .27 |
| Totals ........ | 25.92 | 1.47 | 12.69 | .52 |
| Feeding standard... | 29.00 | 2.50 | 13.00 | .50 |

Comparing the nutrients in the feeds as used above with the standard, it will be seen there is a deficiency in every instance. It will now be necessary to introduce into the ration one or more other feeds in order to correct the faults so evident in the table. Since the greatest deficiency is in the protein, we must seek a supply from among such feeding stuffs as are particularly rich in protein. The oil meals and the gluten meals are of this kind. If, then, we add 2¾ pounds of cottonseed meal, we shall very nearly approximate the standard. The digestible nutrients for this feed are ascertained in the same manner as before, and a second trial made.

FEEDING RATION FOR DAIRY COW

| Feeding stuffs | Dry matter | Digestible nutrients | | |
|---|---|---|---|---|
| | | Protein | Carbo-hydrates | Fat |
| In preceding ...... | 25.92 | 1.47 | 12.69 | .52 |
| 2 ¾ lbs cottonseed meal ............ | 2.55 | 1.03 | .59 | .26 |
| Totals ........ | 28.47 | 2.50 | 13.28 | .78 |
| Feeding standard... | 29.00 | 2.50 | 13.00 | .50 |

In this ration no serious faults are noticed. We have the correct amount of protein, but an excess in carbohydrates of .28 pounds and of fat .28 pounds. The dry matter is slightly under the standard. This does not matter, however, so long as the quantity does not so greatly overrun the standard as to give greater bulk than the average cow has room to accommodate. This deficiency can be considerable and still not affect the efficiency of the ration. The excess of the fuel foods is so small as to be of no importance at all. Were a pound less of clover hay and a quarter of a pound more of cottonseed meal to be used in the ration, the ration would correspond to the standard with considerable exactness.

**Feeding for Heavy Milkers.**—This ration is for dairy cows averaging 22 pounds of milk a day. Suppose a ration is wanted for the same cows at another period when they are giving more milk than in the case just cited, say 27.5 pounds daily. How shall we proceed to adjust this ration to the new requirements, using as nearly as possible the

same feeding stuffs as before? The first step is to consult the standard. This we find calls for 32 pounds of dry matter; 3.3 pounds of protein; 13 pounds of carbohydrates; 0.8 pound of fat.

Our second step will be to consider the feeding stuffs as to the quantity to be used. Obviously, each cow has a certain limit as to storage and digestion capacity for bulky feeds. In the preceding ration we have provided for about all of the corn

HEAVY MILKERS REQUIRE BIG RATIONS

The more milk a cow gives the more she must eat. The biggest eaters are usually the heaviest producers.

stover, silage and clover hay that the average cow can handle. Her limit, therefore, is reached as far as the roughage foods are concerned. We resort, in consequence, to the concentrated mill feeds to supply the additional food required because of the extra milk produced.

Since the ration already contains just about all that a cow of this size can eat, we will prepare a

place in the ration by withdrawing three pounds of the clover hay. We will increase the cottonseed meal to four pounds and add 2½ pounds of gluten feed. This done we have the following:

| Feeding stuffs | Dry matter | Digestible nutrients | | |
|---|---|---|---|---|
| | | Protein | Carbo-hydrates | Fat |
| 10 lbs corn stover | 5.95 | .14 | 3.24 | .07 |
| 30 lbs corn silage | 6.27 | .27 | 3.78 | .18 |
| 12 lbs clover hay.. | 10.12 | .85 | 4.54 | .21 |
| 4 lbs cottonseed meal ............ | 3.76 | 1.50 | .84 | .36 |
| 2½ lbs gluten feed | 2.25 | .53 | 1.30 | .06 |
| Totals ........ | 28.35 | 2.29 | 13.70 | .88 |
| Standard ...... | 32.00 | 3.30 | 13.00 | .80 |

This ration agrees closely with the standard and is assumed to satisfy all the requirements for a cow yielding 27.5 pounds of milk daily and weighing 1,000 pounds.

**Using the Standard in Practical Work.**—Too many people take feeding standards and balanced rations far too seriously. They fail to understand that it is in the spirit and not in their literal use that these feeding aids are to be adopted. The balanced ration at best can be made to approach only approximately the food requirements for any animal or set of animals. This has been pointed out before. The composition of a feeding stuff is always open to considerable variation, and what adds still to the uncertainty is the fact that foods are not digested with equal facility or completeness by dif-

ferent animals, even in the same herd and given the identical feeding stuffs. Moreover, it is both impossible and impracticable to provide a ration for every individual in a herd. To do this would require as many different rations as there are animals to be fed, and definite weighings of every feeding stuff contained in the ration. But all this is unnecessary and no exponent of the balanced ration asks that it be done.

WHERE SCIENCE HELPS TO FATTEN

The man who approximates the feeding standards has an advantage over his competitor who ignores them.

The aim of this scheme in feeding stock is to avoid serious faults in the use of feeding stuffs. Used on broad lines, the balanced ration enables the stock feeder to utilize to the best advantage the plant products which he raises. In case he needs an additional supply he will be fully advised as to what class of available purchased feeds he should obtain in order to secure the greatest efficiency from the food.

**What Foods to Choose.**—On every farm some feeding stuffs are grown that possess little commercial value. These should form the basis of that ration. Corn stover, the straws, legume hays, and silage are all splendid bulk foods, are easily raised on the farm and should be used freely in ration making. They will supply also the greater part of the carbohydrates and fat. The farm, therefore, is the best factory for the production of the fuel nutrients. In the legumes and cereal grains much of the protein will be obtained. If any protein shortage exists it is good business sense to meet it, even though expensive concentrates must be purchased.

The wise farmer will figure the cost of foodstuffs very carefully to find out what is most profitable to feed. It is often best to sell some of the food having a wide nutritive ratio, such as timothy, corn, oats, and wheat, and to purchase foods having a narrow nutritive ratio, such as the oil meals, and the factory by-products. Very often this exchange is made; and not only is the ration improved, thus bringing about better results from the animals under feed, but a money profit is secured in addition to that obtained because of the greater efficiency of the ration.

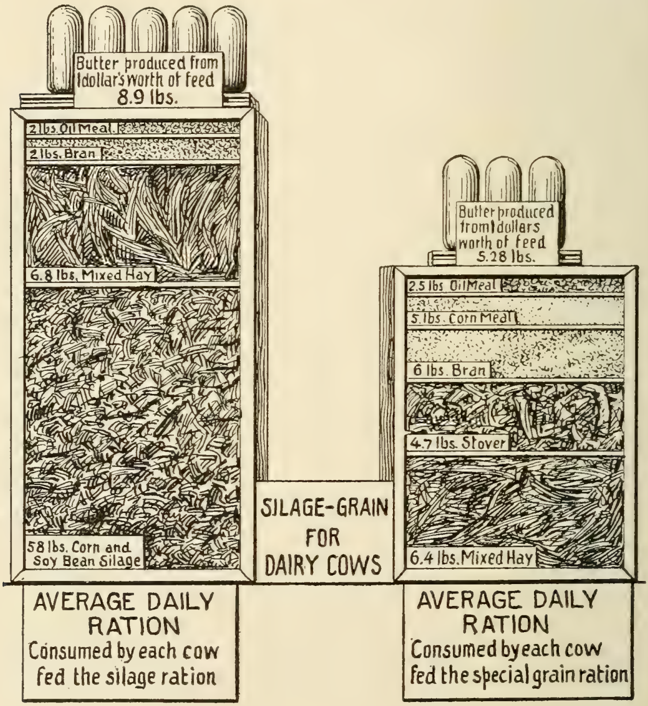
## CHAPTER IX

# BASING STANDARDS ON QUALITY OF MILK

**Oversupply of Protein.**—While the old German standards have been used generally and are still the most popular in this country, many investigators now hold that the protein requirements are higher than practical experience indicates as being necessary. This is particularly the case with dairy cows. Many of our most successful dairymen have obtained as satisfactory results and at less cost by using smaller amounts of protein in the rations as when they literally follow the Wolff feeding standard.

The fact is, all good dairymen use the balanced ration. Many may not do this intentionally, but the feeds they provide follow more or less the standards and furnish approximately the requisite amounts of the digestible nutrients. The feeding stuffs available admit of this. With corn silage, clover hay, cowpea hay, alfalfa, corn stover, mixed hay, the oil meals and the factory by-products, the food requirements are met within reasonable limits, even though the feeder may be unaware of the fact. It is true, nevertheless, that when these rations are analyzed those netting the most profit often show less protein than what the old standards really call for.

It must be remembered that these standards were made many years ago when scientific appliances were less adequate than now, and when little was known about either food or animals. The experiments were also made with German feeds when given to German animals, a circumstance that may




It Pays to Give the Right Feed

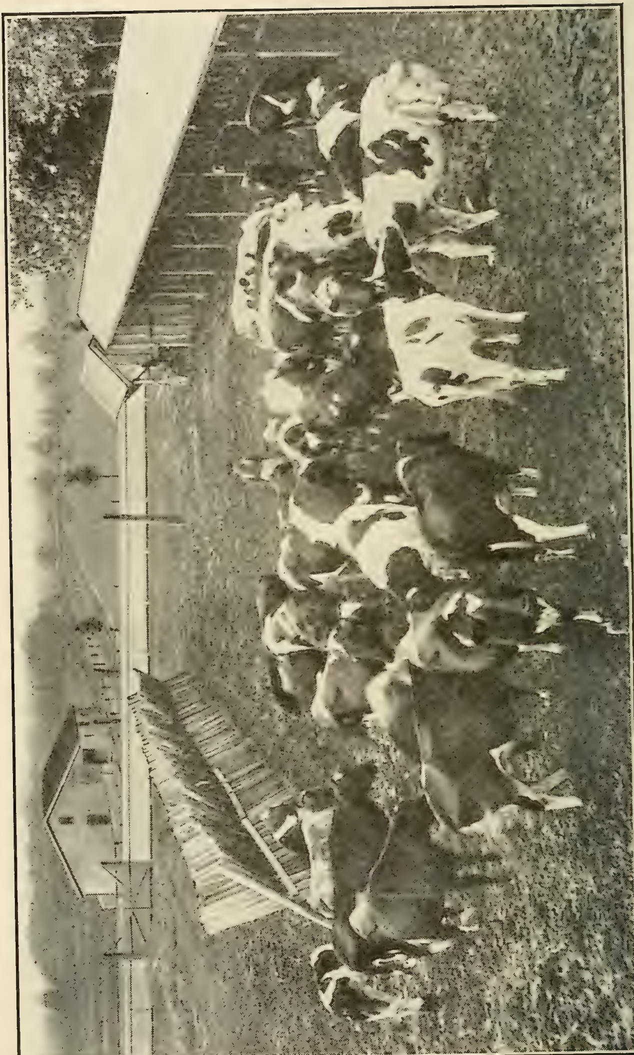
Two rations for dairy cows have been compared. From the one 8.9 pounds of butter were produced from one dollar's worth of feed while from the other but 5.28 pounds of butter was obtained from one dollar's worth of feed. This shows how two rations may cost the same and one may be worth a great deal more for final returns.

be sufficient to modify the standards when American feeds are given American-raised live stock.

Another factor that enters into the problem is the ever-increasing improved quality of our farm animals. On the same food, as Armsby has determined, the pure-bred steer will make better gains than the scrub. If our farm animals are selected for high production, are we not warranted in contributing some part of this increase to the digestive apparatus of the well-bred animal? If the selected strain is better in other respects, does it not improve also in ability to digest and utilize food to the best advantage? Moreover, our feeding stuffs are grown under different soil and climatic conditions and are fed under different environments, and these may account in part for the higher efficiency of our feeding stuffs.

**Haecker's Investigations.**—After a study in various parts of the country of dairy rations some of which demonstrate very practically that less protein would give the same results, Professor Haecker of the Minnesota station undertook a series of experiments to determine, if possible, just what the food requirements are when dairy cows are cared for under average conditions. The results suggested by these experiments are the following:

1. That less protein is required in the ration than called for in the old standard for dairy cows.
2. That the food nutrients should correspond to the quantity of milk given.
3. That the amount of butter fat in the milk must be given due weight in providing the food nutrients.



DAIRY COWS SHOULD BE FED MILK-STIMULATING RATIONS

4. That size and weight of the animal influence the food requirements similarly as worked out in the old standards.

**The Haecker Standard** is based on two general propositions: First, the maintenance requirements of a cow weighing 1,000 pounds; and, second, an additional and shifting allowance of digestible nutrients that is dependent on the per cent of butter fat contained in the milk. The maintenance factor is 0.7 pound of protein, 0.7 pound of carbohydrates and 0.1 pound of fat. For cows weighing more than 1,000 pounds these quantities are proportionately increased, and for cows weighing less than 1,000 pounds they are proportionately decreased. If, for instance, a cow weighs 1,100 pounds, the amounts of each nutrient for maintenance would be as follows: Protein, .77 pound; carbohydrates, .77 pound; and fat, .11 pound.

The additional food requirements are dependent on the quantity and the fat content of the milk as arranged below:

NUTRIENTS REQUIRED BY THE HAECKER STANDARD

| For milk production | | | | In accordance with weight of cow | | | |
|---|---|---|---|---|---|---|---|
| Per cent milk fat | Protein | Carbo-hydrates | Fat | Weight | Protein | Carbo-hydrates | Fat |
| 3.0 | .04 | .19 | .015 | 600 | .42 | 4.2 | .06 |
| 3.5 | .042 | .21 | .016 | 700 | .49 | 4.9 | .07 |
| 4.0 | .046 | .23 | .018 | 800 | .56 | 5.6 | .08 |
| 4.5 | .049 | .26 | .020 | 900 | .63 | 6.3 | .09 |
| 5.0 | .052 | .27 | .021 | 1,000 | .70 | 7.0 | .10 |
| 5.5 | .055 | .29 | .022 | 1,100 | .77 | 7.7 | .11 |
| 6.0 | .057 | .31 | .024 | 1,200 | .84 | 8.4 | .12 |

**How to Establish a Standard.**—It will be observed that no definite standard is provided. It all depends on what the maintenance requirements are, what amount of milk the daily yield is, and on the per cent of butter fat contained. Assuming that a cow weighing 1,000 pounds daily gives 22 pounds of milk, which tests 5 per cent fat, what will be the actual requirements of digestible nutrients according to the Haecker standard? The first step is to consult the table for the nutrient allowance as given for milk of the grade under consideration. This we find to be as follows: Protein, 0.052; carbohydrates, 0.27; and fat, 0.021. But the cow gives 22 pounds daily, in which case the quantities for one pound will be multiplied by 22 to meet the real daily production. The form is as follows:

| | In 1 pound | | In 22 pounds |
|---|---|---|---|
| Protein | .051 | x 22 = | 1.12 |
| Carbohydrates | .27 | x 22 = | 5.95 |
| Fat | .021 | x 22 = | .46 |

These amounts added to what is required for the maintenance of a cow weighing 1,000 pounds and giving 22 pounds of five per cent milk are shown in the table following:

| | Digestible nutrients | | |
|---|---|---|---|
| | Protein | Carbohydrates | Fat |
| Maintenance requirements | .70 | 7.00 | .10 |
| Need for milk yield | 1.12 | 5.95 | .46 |
| Totals | 1.82 | 12.95 | .56 |

**Compared with Wolff Standard.**—From this it is observed that by the Haecker standard when a cow weighs 1,000 pounds and gives daily 22 pounds of 5 per cent milk she will require 1.82 pounds of protein, 12.95 pounds of carbohydrates, and .56 pound of fat. The Wolff standard calls for 2.5 pounds of protein, 13 pounds of carbohydrates, and .5 pound of fat, which conforms very nearly to the Haecker standard in all but the protein, where a difference of .68 pound is observed.

## CHAPTER X

## COMPUTING RATIONS ON BASIS OF STARCH VALUES

**Starch as the Standard Nutrient.**—In the German investigations with fattening oxen conducted by Kellner typical representatives of the several food nutrients were obtained and added one at a time to a ration that gave a slight gain in weight. The amounts of lean meat and fat were determined both before and after the addition of the extra food. The difference between the two gains was then assumed as being a reasonable measure of the fattening effect of the added food. After repeated trials it seemed advisable to use starch as a standard by which other nutrients or feeding stuffs might be measured. The use of this nutrient in this way has given rise to the term *starch value,* which means the quantity by weight of any nutrient, or foodstuff, or ration that is equivalent to starch for fattening or other productive purposes.

**Starch Value Illustrated.**—In one of Kellner's experiments, a certain sample of linseed cake was found to contain 34.5 per cent of digestible protein; 26.1 per cent of digestible carbohydrates, including the fiber; and 8.4 per cent of digestible fat. When 100 pounds of this was fed to a fattening ox, it was found that the increase was the same as when 77 pounds of starch were fed. From this it was con-

cluded that 100 pounds of linseed cake have a starch value, or starch equivalent, of 77 pounds. Other substances—gluten, earthnut oil, potato starch, cane sugar and pulped rye straw—were all used and the weight of fat produced per 100 pounds of the food ingredient digested was obtained, showing averages as follows: Pure protein, 23.5 pounds; fat, 59.8 pounds; potato starch, 24.8 pounds; cane sugar, 18.8 pounds; and crude fiber, 25.3 pounds.

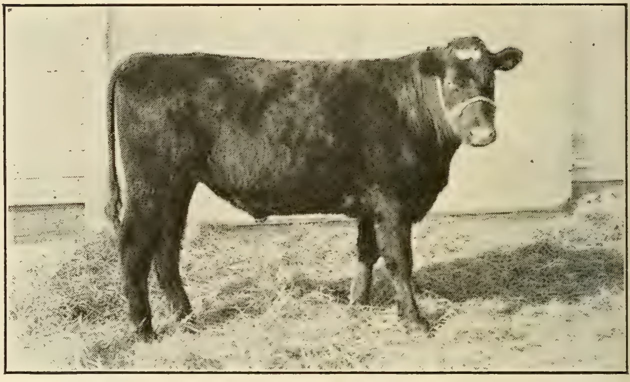
**Relative Starch Values.**—Kellner has devised a method for calculation of values based on the fat-producing ability of starch. He puts starch at 100 and grades the other nutrients to starch in accordance with their fat-producing values. Using starch as the unit of measure, the following values of the other nutrients were found to be as follows:

| Nutrient | Relative starch values | |
|---|---|---|
| | In 100 pounds | In 1 pound |
| Starch | 100 | 1.00 |
| Pulped fiber | 102 | 1.02 |
| Sugar | 76 | .76 |
| Pure protein | 94 | .94 |
| Fat (seeds of certain plants) | 241 | 2.41 |
| Fat (other seeds, etc.) | 212 | 2.12 |
| Fat (coarse fodders, chaff, roots) | 191 | 1.91 |

Here we see that fat or oil ranks first, ranging from 1.91 in roots, chaff and coarse fodders to 2.41 in the important seeds or their by-products, like the oil meals. Sugar is decidedly inferior to starch, the inferiority being due, it is claimed, to fermentation while this nutrient is in the digestive tract. Protein is

nearly on a par with starch. The fiber, when made easily digestible by pulping, is almost exactly equal to starch.

**How to Obtain Starch Value.**—By means of the above table it is an easy matter to calculate the starch value of any feeding stuff or ration. The form is as follows: Multiply the digestible protein by .94; add to this the carbohydrates, fiber, and the fat after multiplying the digestible fat by the percentage cor-



TYPICAL STEER FOR FEEDING
In planning to fatten beeves make certain that the feeding stock is of a high grade. This steer is a fancy selected feeder.

responding to its source. Expressed arithmetically we have the following:

(Digestible protein x .94) + digestible carbohydrates + digestible fiber + (digestible fat $\times$ 2.41 or 2.12 or 1.91) = starch value of 100 pounds.

Using the digestible nutrients in linseed cake, as previously given, we have the following:

$$(34.5 \times .94) + 26.1 + (8.4 \times 2.4) = 78.7$$

Thus the 78.7 pounds represent the calculated starch value of 100 pounds of linseed cake, which actually had the same fattening increase as 77 pounds of starch.

**Actual Starch Value Below Calculated Starch Value.**—When put to actual tests the calculated starch values failed to show an increase in production that the values really indicated them to possess. This is particularly the case with foods containing much fiber. The difference is accounted for in the work occasioned in digesting the foodstuff. Foods like cottonseed meal, linseed meal, corn, etc., possess little fiber, and therefore, the work of mastication and digestion requires only a small part of the nutrients contained in them for their necessary but unproductive purposes. Foods like wheat bran, oat straw, hay, etc., on the other hand, require much labor in the digestive processes, and consequently much of their nutriment is used up in this way.

Kellner has met this difficulty by assigning coefficients of availability to each feeding stuff based on its calculated and actual starch values. Some of these are given on the next page.

Considerable variation is here noted. The oil meals, which carry little fiber, are very largely available on the basis of their calculated starch values. Wheat bran has more fiber and its coefficient of availability drops to 77. The more fibrous meadow hay drops to 70, while oat and wheat straw, with much fiber, go down to 61 and 29 respectively.

**Calculating Starch Values on Basis of Availability.**—To reduce the calculated starch values to their

actual value as indicated by the availability of the digestible nutrients, the following method is pursued: Multiply the digestible protein by its starch equivalent; add to this the digestible carbohydrates, fiber, and the fats after the fat has been multiplied by its starch equivalent; then multiply this sum by the coefficient of availability. The arithmetical re-

OBTAINING THE ACTUAL STARCH VALUE (KELLNER)

| Feeding stuffs | Starch value in 100 pounds | | Percentage of actual as against calculated |
|---|---|---|---|
| | Calculated | Found | |
| | Pounds | | |
| Decorticated cotton-seed meal | 80.0 | 79.0 | 98 |
| Potatoes | 74.0 | 72.5 | 98 |
| Linseed cake | 79.0 | 77.0 | 97 |
| Bean meal | 69.0 | 65.5 | 95 |
| Rye meal | 72.5 | 68.0 | 93 |
| Mangels | 60.0 | 52.0 | 87 |
| Dried grains | 62.0 | 52.0 | 84 |
| Wheat bran | 62.0 | 48.0 | 77 |
| Meadow hay | 57.0 | 38.0 | 67 |
| Oat straw | 43.5 | 26.5 | 60 |
| Wheat straw | 37.0 | 9.0 | 24 |

sult will be the actual starch value. To illustrate: In linseed oil cake containing 34.5 pounds of digestible protein, 26.1 pounds of digestible carbohydrates and fiber and 8.4 pounds of fat what is the actual starch value of 100 pounds of the fresh substance? The process is as follows:

$$((34.5 \times .94) + 26.1 + (8.4 \times 2.4)) \times .97 = 76.3$$

Thus the actual starch value of 100 pounds of linseed cake is 76.3.

**Feeding Stuffs with Much Fiber.**—Kellner recommends that when coarse feeding stuffs and foods containing much fiber are used the correction should be made in accordance with the following schedule:

1. When hay, straw or green food contains 16 per cent or more of crude fiber, reduce the uncorrected calculated starch value by 0.58 for each per cent present.

2. When chaff contains not more than 4 per cent of crude fiber, reduce by 0.29.

Alfalfa Ready for Cutting

Our most profitable farm crop is alfalfa. Fed green, preserved in the silo, ground into meal, or used as hay, it is adapted to all classes and is good for all seasons.

3. When green foods contain between 4 and 16 per cent reduce as follows: For 6 per cent of crude fiber reduce by 0.34 for each per cent; for 8 per cent, 0.38; for 10 per cent, 0.43; for 12 per cent, 0.48; and for 14 per cent, 0.53 starch value.

To illustrate the manner of making these reductions let us assume clover hay contains 5.4 per cent

of digestible protein, 38 per cent digestible carbohydrates and fiber, the total crude fiber being 25 per cent; and 1.5 per cent fat. The process is as follows:

Starch value of 100 pounds $= (5.4 \times .94) + (38 - (25 \times 0.58) + (1.5 \times 1.9) = 30.9$ pounds.

The protein is multiplied by .94, the starch equivalent for protein; the carbohydrates and fiber are reduced in accordance with the reduction factor as assigned for the per cent of the total crude fiber; the fat is multiplied by 1.9, the starch equivalent for fat in clover hay. When these changes are made the starch value of 100 pounds of clover hay is found to be 30.9 pounds.

In case a green fodder is used the process is very similar. Take green alfalfa as an example, the digestible nutrients contained in it being as follows: Digestible protein, 2 per cent; digestible carbohydrates and fiber, 9 per cent; total crude fiber, 7 per cent; digestible fat, 0.5 per cent.

Starch value of 100 pounds $= (2 \times .94) + (9 - (7 \times 0.36) + (0.5 \times 1.9) = 9.31$ pounds.

**Starch Values for All Classes of Stock.**—While Kellner obtained his results from fattening oxen, it is believed the starch values will apply equally well to all classes of animals and for all kinds of productive purposes, provided, of course, enough protein is furnished to meet the body requirements for this food nutrient. A reasonable amount of fat is also necessary if the full starch value of any combination of feeding stuffs is to be secured.

**Feeding Standards on Basis of Starch Values.**—In

the table below are given the daily food requirements for the several classes of farm animals as devised by Kellner and on the basis of 1,000 pounds live weight:

FOOD REQUIREMENTS ON BASIS OF STARCH VALUES (KELLNER)

| Kind of animal | | Dry matter | Digestible protein | Starch values |
|---|---|---|---|---|
| | | Pounds | Pounds | Pounds |
| **Cattle** | | | | |
| Maintenance of steer | | 15 to 21 | 0.6 | 6.0 |
| Fattening steer ..... | | 30 | 2.0 | 15.0 |
| Age | Live weight | | | |
| 6 to 12 mos | 550 | 26 | 3.2 | 14.4 |
| 12 to 18 mos | 770 | 26 | 2.6 | 11.2 |
| 18 to 24 mos | 950 | 26 | 1.8 | 10.0 |
| **Sheep** | | | | |
| 6 to 7 mos | 66 | 31 | 4.0 | 17.0 |
| 7 to 9 mos | 88 | 30 | 3.5 | 16.0 |
| 9 to 11 mos | 110 | 28 | 3.0 | 15.0 |
| **Pigs** | | | | |
| 2 to 3 mos | 44 | 44 | 6.6 | 33.8 |
| 3 to 5 mos | 110 | 36 | 5.6 | 32.0 |
| 5 to 6 mos | 143 | 32 | 4.4 | 26.5 |
| 6 to 8 mos | 198 | 28 | 3.9 | 24.5 |
| 9 to 12 mos | 286 | 25 | 3.2 | 19.9 |
| Last fattening stage | | 26 | 2.6 | 19.8 |
| **Milk cows** | | | | |
| Yielding 20 lbs milk | | 25 to 29 | 1.6 to 1.9 | 12.5 to 14.5 |
| Yielding 30 lbs milk | | 27 to 33 | 2.2 to 2.5 | 11.8 to 13.9 |
| Yielding 40 lbs milk | | 27 to 34 | 2.8 to 3.2 | 13.9 to 16.6 |
| **Horses** | | | | |
| Light work ......... | | 18 to 23 | 1.0 | 9.2 |
| Medium work ...... | | 21 to 26 | 1.4 | 11.6 |
| Heavy work ........ | | 23 to 28 | 2.0 | 15.0 |

See Appendix for complete list of Kellner standards.

**Method of Computing a Ration.**—There are available for feeding a herd of cows clover hay, oats, green alfalfa and linseed cake. These feeding stuffs, if of good average quality, will furnish in 100 pounds the nutrients as given on the next page.

| Feeding stuffs | Dry matter | Digestible nutrients | | | Total crude fiber |
|---|---|---|---|---|---|
| | | Protein | Carbo-hydrates | Fat | |
| Clover hay..... | 84.7 | 5.41 | 38.0 | 1.5 | 25.0 |
| Oats .......... | 89.0 | 9.0 | 45.0 | 5.0 | |
| Linseed cake .. | 90.8 | 25.0 | 32.0 | 9.5 | |
| Alfalfa (green) | 28.2 | 2.0 | 9.0 | 5.0 | 7.0 |

The cows average, let us say, 1,000 pounds in weight, and yield on an average 30 pounds of milk daily. According to the standard the total feed requirements per day and head will be as follows: Dry matter, 27 to 33 pounds; digestible protein, 2.2 to 2.5 pounds; starch value, 11.8 to 13.9 pounds.

The first step is to determine the starch value of each of these feeding stuffs. Taking the feeds in order, the following calculation will be made:

1. Starch value, 100 pounds linseed cake $= ((25 \times .94) + 32 + (9.5 \times 2.4)) \times .97 = 76.3$
2. Starch value, 100 pounds oats $= ((9 \times .94) + 45 + (5 \times 2.1)) \times .95 = 60.8$
3. Starch value, 100 pounds clover hay $= (5.4 \times .94) + (38 - (25 \times 0.58) + (1.5 \times 1.9) = 30.9$
4. Starch value, 100 pounds green alfalfa $= (2 \times .94) + (9 - (7 \times 36) + (0.5 \times 1.9) = 9.31$

The next step in the construction of the ration is to choose the quantity of each feed that is to be used. This will be governed by what is good practice, leaving the actual balancing of the ration to the concentrates that are to be supplied in addition. As a

trial we will use 12 pounds of clover hay, 20 pounds of green alfalfa and 10 pounds of oats. These, properly arranged, show the following:

TRIAL RATION FOR 1,000-POUND DAIRY COW

| Feeding stuffs | Dry matter | Digestible protein | Starch values |
|---|---|---|---|
| | Pounds | Pounds | Pounds |
| 10 lbs clover hay .... | 8.47 | 0.54 | 3.09 |
| 20 lbs green alfalfa .. | 5.64 | 0.50 | 1.86 |
| 7 lbs oats ......... | 6.23 | 0.63 | 4.75 |
| Totals .......... | 20.34 | 1.67 | 9.71 |
| Standard ........ | 27 to 33 | 2.2 to 2.5 | 11.8 to 13.9 |

On comparing with the standard, it is found that the trial ration is slightly under in all respects. To correct this we add three pounds of linseed cake. This done, we have:

| Feeding stuffs | Dry matter | Digestible protein | Starch values |
|---|---|---|---|
| | Pounds | Pounds | Pounds |
| 12 lbs clover hay ... | 10.11 | 0.65 | 3.70 |
| 20 lbs green alfalfa.. | 5.64 | 0.50 | 1.86 |
| 7 lbs oats .......... | 6.23 | 0.63 | 4.76 |
| 3 lbs linseed cake meal .............. | 2.94 | 0.75 | 2.38 |
| Totals .......... | 24.92 | 2.43 | 12.70 |
| Standard ........ | 27 to 33 | 2.2 to 2.5 | 11.8 to 13.9 |

The second trial ration meets the requirements for protein and starch values, but is slightly under in dry matter. From this we see that 10 pounds of

clover hay, 20 pounds of green alfalfa, 7 pounds of oats and 3 pounds of linseed cake meal make a satisfactory ration for dairy cows giving 30 pounds of milk daily and weighing 1,000 pounds. This is in accordance with the Kellner standard, is in line with good practice, and in general is consistent with the other standards used in the calculations of rations for dairy cows.

## CHAPTER XI

# USING ENERGY VALUES FOR COMPUTING RATIONS

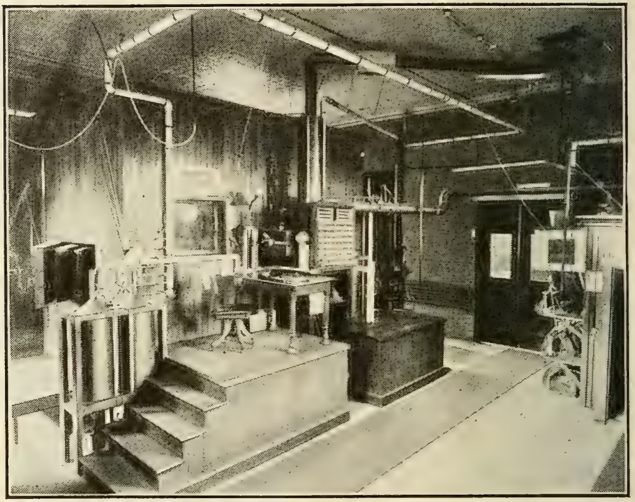
**Feeding Stuffs Possess Energy.**—When food is consumed and utilized in the animal system vital and muscular energy is produced. Any feeding stuff, therefore, is fuel for the animal that consumes it. The chemical energy contained in that food will be set free just as the energy stored in coal or wood or oil or alcohol is set free when burned in an engine. In either case heat is developed and work results.

The value of any material as a fuel substance will naturally depend on how much chemical energy that material contains. Both the quantity and the quality must be determined in order to get a fair measure of its energy value. Armsby[1] has worked out a plan for utilizing these energy values in feeding farm animals. He not only has prepared tables that show the energy value of a number of feeding stuffs, but has formulated feeding standards and a prac-

[1]The idea of using energy values in the computation of rations for farm animals originated with Dr. Kellner of Germany. Dr. Henry Prentiss Armsby, Director of the Institute of Animal Nutrition of the Pennsylvania State College, has expressed the energy value of the feed in still another manner. Kellner attempted to express energy value as starch value because this is so familiarly known. Armsby, on the other hand, has followed the simpler and more direct manner of expressing these values by coming out boldly and entirely to the energy notations, using the therm as the unit instead of the calorie, simply to avoid unnecessarily large numbers. Either manner of expression is entirely justifiable, and in the two methods the values are identical.

tical plan for computing rations for farm animals based on them.

**Units of Measuring Heat.**—Quite generally the fuel value of any material is expressed in *calories.* A calorie is the amount of heat required to raise one pound of water four degrees Fahrenheit. In the



LABORATORY WHERE FOOD VALUES ARE DETERMINED

This picture gives a general view of Armsby's respiration apparatus for determining the net energy of the feeding stuffs.

Armsby standards the fuel or net energy value is expressed in *therms.* A therm is the quantity of heat required to raise the temperature of 1,000 kilograms of water one degree centigrade; it equals 1,000 calories and therefore represents the amount of heat required to raise 1,000 pounds of water four degrees Fahrenheit.

**Waste of Chemical Energy.**—Not all the energy contained in a feeding stuff or ration is utilized. A certain quantity is never digested, but is excreted as dung. Another loss of chemical energy arises from combustible gases due to fermentation of feed in the digestive tract. Still another source of lost energy is material passing out of the system in urine. Armsby states that 22 per cent of the chemical energy of corn meal and 55 per cent of that of average hay has been found to escape in these ways.

But one of the most important causes of energy loss is that occasioned by the processes of digestion, in which the energy that is utilized for fattening increase or other productive uses must be separated from the consumed material.

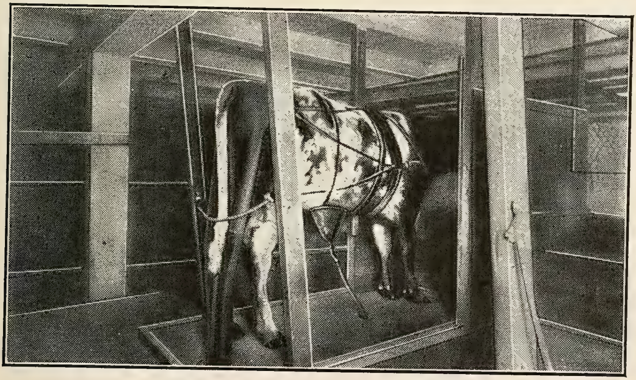
All of these factors enter into the digestive problem and consume much of the contained nutrients for other functions than those of tissue or fat increase, or fuel, or energy.

**Energy Values in Feeds.**—Feeding stuffs possess both a maximum amount of chemical energy and a certain quantity of *net energy*. The former refers to the theoretical quantity, and the latter to that which is actually available for productive uses. It is with the net energy that the feeder has to deal in the preparation of his rations. From tests made by means of the respiration calorimeter much definite knowledge has been obtained, so as to permit approximate estimates showing the net energy in connection with the total dry matter and digestible protein. This is shown in the following table:

DRY MATTER, DIGESTIBLE PROTEIN, AND ENERGY VALUES IN 100 POUNDS (ARMSBY)

| Feeding stuffs | Total dry matter | Digestible protein | Energy value |
|---|---|---|---|
| | Pounds | Pounds | Therms |
| Green fodder and silage | | | |
| Alfalfa | 28.2 | 2.50 | 12.45 |
| Clover (crimson) | 19.1 | 2.19 | 11.30 |
| Clover (red) | 29.2 | 2.21 | 16.17 |
| Corn fodder (green) | 20.7 | 0.41 | 12.44 |
| Corn silage | 25.6 | 1.21 | 16.56 |
| Hungarian grass | 28.9 | 1.33 | 14.76 |
| Rape | 14.3 | 2.16 | 11.43 |
| Rye | 23.4 | 1.44 | 11.63 |
| Timothy | 38.4 | 1.04 | 19.08 |
| Hay and dry coarse fodders | | | |
| Alfalfa hay | 91.6 | 6.93 | 34.41 |
| Clover hay (red) | 84.7 | 5.41 | 34.74 |
| Corn forage, (field cured | 57.8 | 2.13 | 30.53 |
| Corn stover | 59.5 | 1.80 | 26.53 |
| Cowpea hay | 89.3 | 8.57 | 42.76 |
| Hungarian hay | 92.3 | 3.00 | 44.03 |
| Oat hay | 84.0 | 2.59 | 36.97 |
| Soy bean hay | 88.7 | 7.68 | 38.65 |
| Timothy hay | 86.8 | 2.05 | 33.56 |
| Straws | | | |
| Oat straw | 90.8 | 1.09 | 21.21 |
| Rye straw | 92.9 | 0.63 | 20.87 |
| Wheat straw | 90.4 | 0.37 | 16.56 |
| Roots and tubers | | | |
| Carrots | 11.4 | 0.37 | 7.82 |
| Mangel-wurzels | 9.1 | 0.14 | 4.62 |
| Potatoes | 21.1 | 0.45 | 18.05 |
| Rutabagas | 11.4 | 0.88 | 8.00 |
| Turnips | 9.4 | 0.22 | 5.74 |
| Grains | | | |
| Barley | 89.1 | 8.37 | 80.75 |
| Corn | 89.1 | 6.79 | 88.84 |
| Corn-and-cob meal | 84.9 | 4.53 | 72.05 |
| Oats | 89.0 | 8.36 | 66.27 |
| Pea meal | 89.5 | 16.77 | 71.75 |
| Rye | 88.4 | 8.12 | 81.72 |
| Wheat | 89.5 | 8.90 | 82.63 |
| By-products | | | |
| Brewers' grains (dried) | 92.0 | 19.04 | 60.01 |
| Brewers' grain (wet) | 24.3 | 3.81 | 14.82 |
| Buckwheat middlings | 88.2 | 22.34 | 75.92 |
| Cottonseed meal | 91.8 | 35.15 | 84.20 |

| Feeding stuffs | Total dry matter | Digestible protein | Energy value |
|---|---|---|---|
| By-products—Continued | Pounds | Pounds | Therms |
| Distillers' grains (dried) | | | |
| Principally corn .... | 93.0 | 21.93 | 79.23 |
| Principally rye ..... | 93.2 | 10.38 | 60.93 |
| Gluten feed (dried)... | 91.9 | 19.95 | 79.32 |
| Gluten meal (Buffalo). | 91.8 | 21.56 | 88.80 |
| Gluten meal (Chicago) | 90.5 | 33.09 | 78.49 |
| Linseed meal (old process) ........... | 90.8 | 27.54 | 78.92 |
| Linseed meal (new process) ........... | 90.1 | 29.26 | 74.67 |
| Malt sprouts ......... | 89.8 | 12.36 | 46.33 |
| Rye bran ............. | 88.2 | 11.35 | 56.65 |
| Sugar-beet pulp (fresh) | 10.1 | 0.63 | 7.77 |
| Sugar-beet pulp (dried) | 93.6 | 6.80 | 60.10 |
| Wheat bran .......... | 88.1 | 10.21 | 48.23 |
| Wheat middlings ..... | 84.0 | 12.79 | 77.65 |



REVEALING FACTS ABOUT DIGESTION

The steer is harnessed in apparatus as used by Dr. Armsby in his digestion experiments.

**Requirements for Maintenance.**—Armsby has included the results of Kellner's experiments with his own, and from these he has devised certain guides to be used in connection with the food requirements for different classes of farm animals. He first takes

up the maintenance requirements, or the amount of digestible protein and net energy necessary for an animal when making no growth or other production, or when doing no work. Standards for swine are not included, as no satisfactory figures are available. The maintenance standards suggested are as follows:

MAINTENANCE STANDARD FOR CATTLE, HORSES AND SHEEP (ARMSBY)

| | Cattle | | Horses | | Sheep | | |
|---|---|---|---|---|---|---|---|
| Live Weight | Digestible protein | Energy value | Digestible protein | Energy value | Live weight | Digestible protein | Energy value |
| Lbs | Lbs | Therms | Lbs | Therms | Lbs | Lbs | Therms |
| 150 | 0.15 | 1.70 | 0.30 | 2.00 | 20 | 0.23 | 0.30 |
| 250 | 0.20 | 2.40 | 0.40 | 2.80 | 40 | 0.05 | 0.54 |
| 500 | 0.30 | 3.80 | 0.60 | 4.40 | 60 | 0.07 | 0.71 |
| 750 | 0.40 | 4.95 | 0.80 | 5.80 | 80 | 0.09 | 0.87 |
| 1,000 | 0.50 | 6.00 | 1.00 | 7.00 | 100 | 0.10 | 1.00 |
| 1,250 | 0.60 | 7.00 | 1.20 | 8.15 | 120 | 0.11 | 1.13 |
| 1,500 | 0.65 | 7.90 | 1.30 | 9.20 | 140 | 0.13 | 1.25 |

**Requirements for Growth.**—Young animals consume more food than adult animals in relation to the weight of the body. They lay on much less fat and carry much more water in their increase. As they grow older and exercise more freely, additional supplies of food are necessary for the production of heat and mechanical work. These demands give rise to a constantly changing balance of food nutrients. The following estimates are for growing cattle and sheep:

ENERGY VALUE OF ONE POUND OF GAIN IN WEIGHT (ARMSBY)

| Age | Energy value |
|---|---|
| Months | Therms |
| 3 | 1.50 |
| 6 | 1.75 |
| 12 | 2.00 |
| 18 | 2.50 |
| 24 | 2.75 |
| 30 | 3.00 |

These figures apply to growth only. The requirements for maintenance must be added to get the amount necessary for both purposes. This has been done in the following table:

DAILY REQUIREMENTS FOR GROWTH AND MAINTENANCE (ARMSBY)

| Cattle | | | | Sheep | | | |
|---|---|---|---|---|---|---|---|
| Age | Live weight | Digestible protein | Energy value | Age | Live weight | Digestible protein | Energy value |
| Mo's | Lbs | Lbs | Therms | Mo's | Lbs | Lbs | Therms |
| 3 | 275 | 1.10 | 5.0 | 6 | 70 | 0.30 | 1.30 |
| 6 | 425 | 1.30 | 6.0 | 9 | 90 | 0.25 | 1.40 |
| 12 | 650 | 1.65 | 7.0 | 12 | 110 | 0.23 | 1.40 |
| 18 | 850 | 1.70 | 7.5 | 15 | 130 | 0.23 | 1.50 |
| 24 | 1,000 | 1.75 | 8.0 | 18 | 145 | 0.22 | 1.60 |
| 30 | 1,100 | 1.65 | 8.0 | | | | |

**Requirements for Fattening.**—Armsby estimates that fairly mature steers from two to three years of

age will require approximately 3.5 therms a pound of gain in live weight.

**Requirements for Milk.**—Armsby estimates that for the production of milk containing 13 per cent of total solids and 4 per cent of fat approximately 0.3 of one therm of production value in the feed will be required daily.

**Requirements for Work.**—The estimate below is for work horses weighing 1,000 pounds. Both the work and maintenance requirements are included:

REQUIREMENTS FOR WORK HORSES (ARMSBY)

| Kind of work | Digestible protein | Energy value |
|---|---|---|
| | Pounds | Therms |
| For light work ...... | 1.0 | 9.80 |
| For medium work ... | 1.4 | 12.40 |
| For heavy work ..... | 2.0 | 16.00 |

**Computing a Ration for Steers.**—Suppose a steer weighing 1,000 pounds is to be brought to weigh 1,500 pounds in 250 days. This will mean an average daily gain of two pounds, just what in practice is considered satisfactory. Our problem is to prepare a suitable ration at reasonable cost to do this. How shall we proceed?

As a satisfactory starting point we will need to determine the number of therms of energy value needed for two pounds of daily increase. Taking the standard, 3.5 therms for one pound of gain, this steer would require 7 therms of energy value each day as the fattening requirement. Taking 1,250 pounds as the average weight during the feeding period,

the maintenance requirements as set forth by Armsby will be 7 therms for an animal making this daily gain in weight. This, added to what is required for fattening increase, will bring the total energy requirement to 14 therms of net energy for each day up to the time when the steer weighs 1,250 pounds. The protein requirements for this steer, as given

MATURE STEERS NEARLY READY FOR MARKET

Many steers are finished at pasture, the grain supply being increased as the fattening period advances. Pasture as the sole feed is not best for finishing fattening animals.

previously, are 1.65 pounds daily The complete standard, then, will be as follows: Digestible protein, 1.65 pounds; energy value, 14 therms.

Our second step is to select the feeding stuffs and to combine them in such proportion as will best meet the feeding standard. Let us assume that clover hay is available as roughage, and corn and cob meal as a concentrate. In practice we know

that 10 pounds of hay and 15 pounds of grain are often used in that proportion as a beef ration. Our problem is to learn how nearly this combination of the amounts given approaches the standard and if any additional food may be given so as to improve on the ration. By consulting the table giving the protein and energy values of feeding stuffs, we find that in 100 pounds of clover hay there are 34.7 therms energy value, and in corn and cob meal 72.0 therms. Therefore we have:

| | Therms |
|---|---|
| In 100 pounds of clover hay .......................... | 34.7 |
| In 150 pounds of corn and cob meal ................. | 108.0 |
| In 250 pounds of feed .............................. | 142.7 |
| In 1 pound ........................................ | .565 |

To supply 14 therms divide 14 by .565 to obtain the number of pounds of this combination for the daily energy requirements.

Thus, $14 \div .565 = 24.8$ pounds, of which $^{10}/_{25}$, or 9.9 pounds, is to be clover hay and $^{18}/_{25}$, or 14.9 pounds, is to be corn and cob meal, or 10 and 15 pounds each approximately. This quantity meets the energy requirement, but is there enough or too much protein? This will be determined by proceeding as below:

| Feeding stuffs | Dry matter | Digestible nutrients | |
|---|---|---|---|
| | | Protein | Energy value |
| | Pounds | Pounds | Therms |
| 10 pounds clover hay ........ | 8.87 | 0.54 | 3.47 |
| 15 pounds corn and cob meal | 9.34 | 0.68 | 10.81 |
| Totals .................. | 18.21 | 1.22 | 14.28 |
| Standard ................ | | 1.65 | 14.00 |

Here we find the protein is under, and the energy value slightly over, the daily requirements. The ration is, therefore, not quite satisfactory. To improve it we will reduce the corn and cob meal by three pounds and add two pounds of cottonseed meal. The ration will then be as follows:

| Feeding stuffs | Dry matter | Digestible nutrients | |
|---|---|---|---|
| | | Protein | Energy value |
| | Pounds | Pounds | Therms |
| 10 pounds clover hay ........ | 8.87 | 0.54 | 3.47 |
| 12 pounds corn and cob meal. | 7.47 | 0.55 | 8.65 |
| 2 pounds cottonseed meal.... | 1.83 | 0.70 | 1.68 |
| Totals .................. | 18.17 | 1.79 | 13.80 |
| Standard ............... | | 1.65 | 14.00 |

By substituting two pounds of cottonseed meal for three pounds of corn and cob meal the ration has been greatly improved, since the deficiency of protein has been brought up to, and even beyond, the standard. The revised ration almost exactly approximates the standard in energy value, and, also, the quantity of dry matter is easily handled by a steer of this age and weight.

**Computing a Ration for Dairy Cows.**—If a ration is to be computed for dairy cows the first step will be to determine the food requirements. If it is assumed that the cows weigh 1,000 pounds and yield daily 25 pounds of milk, there will be needed 0.5 of a pound of digestible protein and 6.00 therms of energy for maintenance. For the production of 25

pounds of milk there will be needed 1.25 ($0.05 \times 25$) pounds of digestible protein and 7.5 ($0.3 \times 25$) therms of energy value. The total daily food requirements per animal will therefore be:

| Purpose | Digestible protein | Energy value |
|---|---|---|
| | Pounds | Therms |
| For maintenance ....... | 0.50 | 6.00 |
| For 25 pounds milk .... | 1.25 | 7.50 |
| Totals ............. | 1.75 | 13.50 |

The second step in the computation is to decide on the kind and quantity of the feeding stuffs. Assuming that corn stover, corn silage, and clover hay are available, we will use such quantities as have been found in practice to be satisfactory, although used in varying quantities. As a starting point, we will use 5 pounds of corn stover, 10 pounds of clover hay and 30 pounds of corn silage. Consulting the table giving the digestible protein and energy values, we find that in 100 pounds of each of the above feeding stuffs the following will be furnished:

| Feeding stuffs | Dry matter | Digestible protein | Energy value |
|---|---|---|---|
| | Pounds | Pounds | Therms |
| Corn stover ..... | 59.5 | 1.80 | 26.53 |
| Clover hay ...... | 84.7 | 5.41 | 34.74 |
| Corn silage ..... | 25.6 | 1.21 | 16.56 |

We now calculate the amounts of digestible protein and of energy contained in the quantity of each feed selected and arrange them as below:

TRYING OUT THE RATION COMPARED WITH THE ARMSBY STANDARD

| Feeding stuffs | Dry matter | Digestible protein | Energy value |
|---|---|---|---|
| | Pounds | Pounds | Therms |
| 5 pounds corn stover ...... | 2.97 | 0.09 | 1.33 |
| 10 pounds clover hay ....... | 8.47 | 0.54 | 3.47 |
| 30 pounds corn silage....... | 7.68 | 0.36 | 4.95 |
| Totals ................. | 19.12 | 0.99 | 9.75 |
| Standard .............. | | 1.75 | 13.50 |

Compared with the standard we find a deficiency in every instance, therefore it will now be necessary to introduce into the ration one or more feeds to correct the faults so evident in this trial ration. Since there is a greater lack of the protein than of energy value, we will select concentrates from among such feeding stuffs as are particularly rich in protein. Suppose we use 1 pound of gluten meal, 1 pound of cottonseed meal and 3 pounds of dried beet pulp, and add these to the ration.

SECOND TRIAL RATION FOR DAIRY COWS

| Feeding stuffs | Dry matter | Digestible protein | Energy value |
|---|---|---|---|
| | Pounds | Pounds | Therms |
| 5 pounds corn stover ..... | 2.97 | 0.09 | 1.33 |
| 10 pounds clover hay ....... | 8.47 | 0.54 | 3.47 |
| 30 pounds corn silage ....... | 7.68 | 0.36 | 4.95 |
| 1 pound cottonseed meal ... | 0.91 | 0.35 | 0.84 |
| 1 pound gluten meal ...... | 0.91 | 0.21 | 0.88 |
| 3 pounds dried beet pulp .. | 2.80 | 0.20 | 1.80 |
| Totals ................. | 23.74 | 1.75 | 13.27 |
| Standard .............. | | 1.75 | 13.50 |

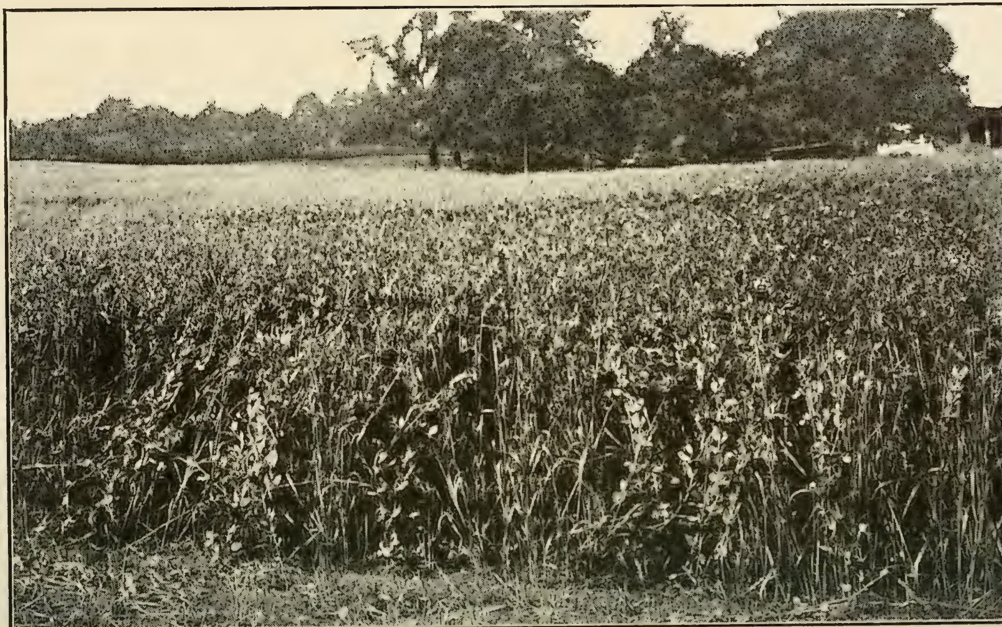
The second trial corresponds very nearly to the standard. The protein does this with exactness, while the energy value is just slightly under what the standard calls for. This is of small importance since, as explained heretofore, it is not expected that the rations shall be made to meet the standards with mathematical accuracy. The aim should be to approximate them. From this we learn that, according to the Armsby standard, a satisfactory ration for milk cows weighing 1,000 pounds and yielding 25 pounds of milk daily may consist of 5 pounds of corn stover, 10 pounds of clover hay, 30 pounds of silage, 1 pound of cottonseed meal, 1 pound of gluten meal, and 3 pounds of dried beet pulp.

## CHAPTER XII

# THE COST OF THE RATION

**The Practical Question.**—Secondary only in importance to a proper balance of the feeds is the cost of the ration. It is much to have a ration approximate the theoretical standard, since it is necessary to get the digestible nutrients in reasonable proportion in order to obtain success in the feed lot or the dairy stable. A dairy cow, if given an insufficient amount of protein, will show the shortage sooner or later in her milk yield; and the beef steer, while he may make good gains by laying on fat, will lack quality at the block and will show gains, likely, at considerable cost. In both instances if some of the non-nitrogenous feeding stuffs were to be exchanged for one or more of a more protein nature, the productive ends might be more perceptible and the units of gain might be more cheaply acquired.

It is always important to use as the basis of every farm ration just as much of the farm-raised feeds as is possible. In the first place farm animals provide a market right at home, and at the same time they are generous to the farm because of the manure they return to the soil. The less feed that is purchased the less the labor required to get concentrated grains from the distributing centers. Nevertheless, it is generally profitable to use some of the mill concentrates for purposes of balancing the ration and to



OATS AND PEAS ARE EXCELLENT FOR HAY OR SOILING

induce larger consumption—two conditions always consistent with large production with any class of animals. However, there is much objection to heavy grain feeding, as every practical feeder knows. What profit is there in expending much for grain if the additional production is wholly absorbed in the feed bills? Much has been said and written in recent years about the proper proportion of grain to roughage in the feeding ration. In the past, perhaps, the roughage allotment in proportion to the grain was too large, and to-day perhaps it is the reverse.

**Two Rations Compared on Basis of Cost.**—Some years ago two rations were compared in milk production at the Ohio station. One consisted largely of a corn-soybean-cowpea silage, and mixed hay; and the other of more than half grain. The first produced 96.7 pounds of milk for each 100 pounds, based on the dry matter contained in it, and the second 81.3 pounds of milk for each 100 pounds, based on the dry matter in it. In the one, the silage ration, 89 per cent was of a roughage nature or farm-raised food, while in the other, 43 per cent, or just about half as much, was farm-raised. The two rations are given in the table on the following page.

The practical question that arises is this: If both are available today, which would cost the more? That depends on the prices at which each could be purchased; and each and every feeder will need to determine that point for himself. However, let us assume the following as fair prices for the feeds: Corn silage, $2 a ton; corn stover, $5; mixed hay, $12;

linseed oil meal, \$34; wheat bran, \$30; and corn meal, \$30. At these prices a pound of silage will be worth .1 cent; of corn stover, .4 cent; mixed hay, .6 cent; oil meal, 1.7 cents; bran, 1.5 cents; and corn meal, 1.5 cents. The cost of the two rations would therefore be as follows:

Silage = (58 × .1) + (6.8 × .6) + (2 × 1.5) + (2 × 1.5) = 15.88

Grain = (4.7 × .4) + (6.4 × .6) + (2.5 × 1.5) + (5 × 1.5) + (6 × 1.5) = 25.97

25.97 — 15.88 = 10.09 cents, the difference in cost of the rations.

SILAGE VERSUS GRAIN FOR MILK COWS

| Pounds | Feed | Dry matter Pounds | Protein[1] Pounds | Crude fiber[1] Pounds | Nitrogen-free extract[1] Pounds | Ether extract[1] Pounds |
|---|---|---|---|---|---|---|
| | | I—Silage ration | | | | |
| 58.0 | Silage | 10.83 | 1.37 | 2.71 | 5.43 | 0.53 |
| 6.8 | Mixed hay | 5.77 | 0.55 | 1.90 | 2.76 | 0.21 |
| 2.0 | Oil meal | 1.80 | 0.66 | 0.19 | 0.77 | 0.06 |
| 2.0 | Bran | 1.76 | 0.31 | 0.18 | 1.08 | 0.08 |
| | Total | 20.16 | 2.89 | 4.98 | 10.04 | 0.88 |
| | | II—Grain ration | | | | |
| 4.7 | Stover | 3.29 | 0.21 | 1.15 | 1.70 | 0.06 |
| 6.4 | Mixed hay | 5.43 | 0.52 | 1.79 | 2.60 | 0.19 |
| 2.5 | Oil meal | 2.25 | 0.83 | 0.24 | 0.96 | 0.08 |
| 5.0 | Corn meal | 4.25 | 0.46 | 0.09 | 3.43 | 0.19 |
| 6.0 | Bran | 5.29 | 0.92 | 0.54 | 3.23 | 0.24 |
| | Total | 20.51 | 2.94 | 3.81 | 11.92 | 0.76 |

[1] In these rations the total composition is given, and not the digestible nutrients.

Both of the rations approximate the standard for dairy cows, and both are equally good since they are productive of a good milk yield. Yet when compared from the standpoint of cost there is a difference of 10.09 cents. It might seem a matter of small consequence for a single day and a single cow, but for a winter feeding period of seven months and 40 cows in a herd it assumes a new importance. This is seen when the simple calculation is made. We have—

$$210 \text{ days} \times 40 \text{ cows} \times 10.09 \text{ cents} = \$847.50$$

Thus the grain ration, which actually produced 15.4 pounds less milk for each 100 pounds of dry matter, if used instead of the silage ration, provided it was available, would mean a net cost of nearly $850 more than the other. This amount is sufficient to make this dairy venture either a losing or a profitable proposition.

**Two Rations for Horses Compared.**—A common ration for horses is timothy hay and oats. When doing severe work 10 pounds of hay and 14 pounds of oats are commonly recommended and used. At prevailing prices of $16 a ton for hay and 56 cents a bushel for oats, the daily cost would be:

$$(10 \times (\$16 \div 2{,}000)) + (14 \times (.56 \div 32)) = 32.5 \text{ cents}$$

At the prices just quoted the daily cost for feeding a medium-sized horse at hard work would be 32.5 cents a day. The practical question to ask is this: Is it possible to substitute some other feed or feeds for the more expensive oats and thus reduce the daily cost? It is. From many tests made many

substitutes may be chosen. Corn, wheat bran, oil meal, cottonseed meal, brewers' grains and many other feeding stuffs can be substituted for oats. Suppose we use 9 pounds of corn and 2 pounds of oil meal in place of 14 pounds of oats. The nutrients of the two will be as follows:

OATS VERSUS CORN AND OIL MEAL

| Feed | Digestible nutrients | | |
|---|---|---|---|
| | Protein | Carbohydrates | Fat |
| 14 pounds oats ........ | 1.28 | 6.62 | 0.58 |
| 9 pounds corn and 2 pounds oil meal ..... | 1.29 | 6.64 | 0.52 |

From the standpoint of nutrients these two are approximately equal. Let us compare the two as to cost when oats are worth 56 cents a bushel, corn 65 cents a bushel, and oil meal $30 a ton. In both rations 10 pounds of hay are to be given, and hence the cost will rest with the kind of grain provided. The cost of the two grain rations will be as follows:

Corn and oil meal $= (9 \times (.65 \div 56)) + (2 \times (\$30 \div 2{,}000)) = 13.4$ cents

Oats $= 14 \times (.56 \div 32) = 24.5$ cents

Thus at prices quoted, but substituting 9 pounds of corn and 2 pounds of oil meal for 14 pounds of oats, the same quantity of digestible nutrients can be obtained and at a daily saving of 11.1 cents a horse. If six horses are kept and are fed in accordance with this saving for the working period of nine months a net saving of $149.82 would result.

**Feeding Stuffs Vary in Price.**—The wise feeder watches the market prices of the various feeds. To a certain extent the law of supply and demand fixes the prices for most feeds. When the corn crop is large the price drops, and even influences the value of other feeds, although there may be a short crop of each. Yet from year to year farm grains, hays, and commercial feed crops fluctuate within certain limits from month to month and from year to year. By taking cognizance of this fact and by studying the market values of available and desirable feeding stuffs in relation to their digestible ingredients, substitutions can be made, often at a great saving and frequently with even more favorable results than through the use of the more familiar feeds. See that the combination gives a balanced ration, and then seek good feeds that will continue the balance, selecting those that will most cheaply do it. In this way a handsome profit may often be secured in addition to greater efficiency.

**Easy to Swap Feeds.**—Since transportation is now so easy, an exchange of one class for another is easily made, furnishing no reason why each section should not have such nutrients as it needs to balance properly its standard feeding rations. The farmer who has an abundance of timothy and corn, which he is now feeding his farm stock, can well afford to dispose of a part of one or both and expend the entire receipts for some good substitute of equal or greater efficiency. By so doing he need not increase his outlay at all; but he will supply his animals with a more satisfactory ration.

But there are large quantities of food each year going to waste in every section. Thousands and thousands of tons of corn stover, cottonseed meal, and the by-products of the slaughtering houses rot each year in American farm fields. The quantity of this rich animal food and real wealth is so vast as to be almost beyond estimation. Much of it is wasted and unutilized each year. Of course, these

CONVERTING CORN INTO COIN

materials help the soil, but they could help the animal first, and to the land might go the resulting manure, doing the land as much good as the raw animal food.

**Use Judgment in Purchasing Feeds.**—Often very poor judgment is shown in the purchase of feeds. Just think of the great quantities of timothy and other hays that are each year sent into some section to be fed to live stock! It is not wise farm

management to buy timothy hay, and yet this practice prevails in many parts of the country. It is not economical feeding. There is no special virtue in timothy hay. A feeding stuff is valuable only in proportion to its ability to furnish protein, carbohydrates and fat. Why buy timothy hay when it is little better than corn stover as a feed? Grow plenty of corn and the legumes, and you need not bother about timothy hay. The good farmer and the wise feeder aims to have some legume crop at all times.

**Grow the Legumes.**—Cowpeas and clovers and alfalfa are needed, not only to catch nitrogen out of the air and store it in the soil so as to maintain the fertility of the land, and add humus thereto, but they are needed as feed for cattle and sheep and hogs and horses. Many feeding experiments have shown that in feeding value, either of these three feeds is not much less than wheat bran.

Many farmers do not grow wheat, yet they buy wheat bran for the protein it contains, because they look upon wheat bran as a valuable feeding stuff. And it is; but, in addition to being good, it is also costly. It takes money from the pocket. Still, if a man could sow ten acres or more each year to a crop of wheat bran, and if he could sow the wheat bran just as he can now sow cowpeas or alfalfa or clover, and if he could get two tons or more of bran an acre, the practice would become general throughout the country. And why? Because every farmer has learned of the value of wheat bran as a feed. But if alfalfa and cowpeas and clover are almost as good as wheat bran for all feeding purposes, why refrain

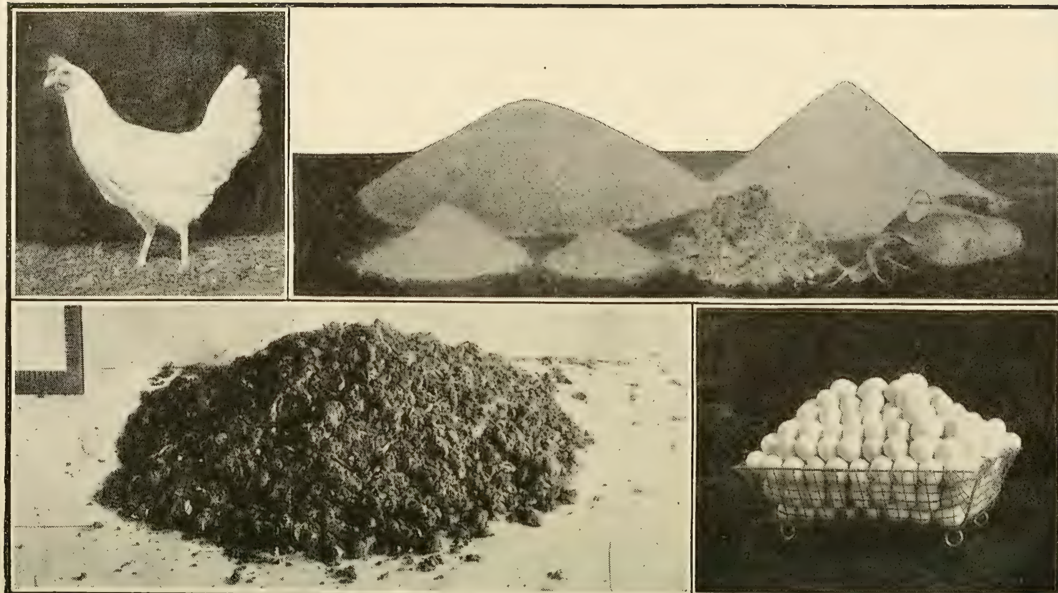
from growing alfalfa, cowpeas and clover when you can get from three to six tons of the former and a ton and a half to three tons an acre of the latter two crops from the land, and by so doing get feeding crops that actually are unexcelled?

## CHAPTER XIII

# COST OF NUTRIENTS

**Bulk Food Should Be Home-Grown.**—Little needs to be said about the importance of growing on the farm all the bulk food required for live stock. For one thing, the greater part of the feeding stuffs can be grown cheaper than they can be bought of someone else. Practically all materials grown on the farm and used for feeding purposes are low in protein but correspondingly high in other nutrients. The farmer can raise all the carbohydrates and fat needed for either the dairy or the block; but, unfortunately, there are no feeding stuffs made up wholly of protein. If there were, the balancing of rations in reference to cost would be a very simple process indeed.

**Protein Not Solely Purchased.**—Though protein is the constituent most needed on most farms when purchased, other nutrients must be taken along with the protein. Carbohydrates and fat are present in all feeding stuffs, and they have a commercial value. Consequently when we buy protein we get carbohydrates and fat also. It should not be understood that these latter constituents are a trouble or a nuisance; they have a value. But you readily see it is unfortunate to purchase them when their like can be secured at home. It suggests the same idea that



REMARKABLE LEGHORN AND HER ACHIEVEMENTS

At the New York State College of Agriculture in Ithaca, Lady Cornell, a Single Comb White Leghorn, weighing 3.2 pounds, ate 110 pounds of food in her first year to produce 257 eggs weighing 29.5 pounds and 73 pounds of voidings. In her second year she laid 200 eggs weighing 23.7 pounds. This record is due to rational feeding coupled with careful management and thoughtful breeding.

a necktie always must be purchased with a collar. One may never wear a necktie, or he may have all the ties he needs at home, yet every time he buys a collar he is obliged to pay for a necktie as well. If a necktie is not needed, but only a collar, it is likely the rule would be to get the collar having the least necktie about it and the value of the purchase depend wholly upon the collar and nothing on the necktie.

If the farmer raises on his farm all he needs of the carbohydrates and fat which have a low commercial value, he cannot afford to buy more of the same constituents at a price many times higher than he can raise them himself. Yet the feeder is obliged to do this very thing when he purchases protein. It cannot be helped and it is no one's fault.

There is a point of practical bearing, however, in this matter. If you have to take carbohydrates and fat along with protein and pay for them, get as little of the carbohydrates and fat in the feeding stuff as possible and just as much protein as you can. The aim should be to buy the feeding stuff having the highest quantity of digestible protein that costs the least for a pound of protein.

Expressed in a few words, a good rule to follow is this: Grow all the carbohydrates and fat on the farm; never be placed in a position that requires you to purchase any. Then grow the protein roughages, like clover, cowpeas and alfalfa, and little protein will need to be bought. This is economical and practical feeding. It is good farming.

**Purchase of Protein.**—It is not always practical or possible under ordinary methods of farm practice

to grow all the protein on the farm. Hence this nutrient must be secured elsewhere. This is done either through purchase of grain materials not raised on the farm, or the purchase of by-products from manufacturing concerns. Bran comes from flour mills, gluten products and meal from the manufacturing of starch, and cottonseed meal from the oil mills, and various other mill products from other forms of manufacture. There is a long list of concentrates as the source of protein consumption. The feeder is interested in knowing which of them he shall purchase. Three things will aid him in the selection: The protein content, the total digestible nutrients, and the market price of the feeding stuff.

A wise selection requires the three to be considered together. For instance, the following foodstuffs at market prices are available to a feeder:

| | |
|---|---|
| Corn | 65 cents a bushel |
| Oats | 56 cents a bushel |
| Gluten meal | $30 a ton |
| Cottonseed meal | $32 a ton |
| Bran | $30 a ton |

Using the above as examples, which shall be selected if the feeder simply desires to get protein for the purpose of balancing a ration, having as its basic constituents feeding stuffs raised on the farm? In other words, if the feeder is abundantly supplied with roughage materials like corn stover, silage, grass, and legume hays, what concentrate shall he select in order to get protein to balance his ration?

The sensible thing to do is to determine which food furnishes a pound of protein at least cost. We find in 100 pounds of each of these feeds the following quantities of protein are to be obtained:

PROTEIN IN CERTAIN FEEDING STUFFS

| Feeding stuffs | Pounds of digestible protein | |
|---|---|---|
| | In 100 pounds | In 1 ton |
| Corn | 7.9 | 158 |
| Oats | 9.2 | 184 |
| Gluten meal | 32.2 | 644 |
| Cottonseed meal | 37.2 | 744 |
| Bran | 12.2 | 244 |

A ton of corn contains 158 pounds of protein, which is worth 65 cents a bushel, or $25 a ton. One pound of protein will therefore cost 2,500 divided by 158, or 15.8+ cents a pound.

In like manner the cost of a pound of protein in each feeding stuff is determined, giving us the following:

| Feeding stuffs | Price per ton | Pounds digestible protein per ton | Cost per pound protein in cents |
|---|---|---|---|
| Corn | $25 | 158 | 15.8 |
| Oats | 35 | 184 | 18.9 |
| Gluten meal | 30 | 644 | 4.5 |
| Cottonseed meal | 32 | 744 | 4.3 |
| Bran | 30 | 244 | 12.3 |

Here we see that at the prices assumed cottonseed meal and gluten meal are by far the cheapest sources of protein.

The same method is followed in determining the protein value of every other foodstuff. So simple is it, every feeder and stockman should make it a point to determine always the feeding values of different feeding stuffs in this comparative manner.

**On Basis of Total Digestible Nutrients.**—The comparative cost of digestible nutrients is determined in the same way and has an important bearing on feeding farm animals. If it is necessary to purchase some grain or concentrated feeding stuff, in addition to a comparison of the protein, let the quantity of total digestible nutrients be taken in consideration also. A feeding stuff that will furnish not only the protein, but the total digestible nutrients, at the cheapest cost per pound, other things being satisfactory, should certainly be the one chosen.

Using the same feeds as before, we have the following:

| Feeding stuffs | Digestible nutrients in 100 pounds | | | | Total digestible nutrients in one ton |
|---|---|---|---|---|---|
| | Protein | Carbohydrates | Fat | Total | |
| Corn ......... | 7.9 | 66.7 | 4.3 | 78.9 | 1,578 |
| Oats .......... | 9.2 | 47.3 | 4.2 | 60.7 | 1,214 |
| Gluten meal .. | 32.2 | 43.3 | 11.0 | 80.1 | 1,730 |
| Cottonseed meal | 37.2 | 16.9 | 12.2 | 66.3 | 1,326 |
| Bran ......... | 12.2 | 39.2 | 2.7 | 54.1 | 1,082 |

In the following table is shown the price a pound of digestible nutrients when the market price a ton and total digestible nutrients are given:

| Feeding stuffs | Market price | Total digestible nutrients | Price in cents per pound of digestible nutrients |
|---|---|---|---|
| Corn .............. | $25 | 1,578 | 1.5 |
| Oats .............. | 35 | 1,214 | 2.8 |
| Gluten meal ....... | 30 | 1,730 | 1.2 |
| Cottonseed meal ... | 32 | 1,326 | 2.4 |
| Bran .............. | 30 | 1,080 | 2.8 |

Here we find that a pound of digestible nutrients is most costly in oats and wheat bran; and cheapest in gluten, corn, and cottonseed meal.

The various kinds of feeding stuffs can be determined in this manner by obtaining the market prices and dividing these prices by the quantities of total digestible nutrients of the respective feeding materials. Taking these facts in consideration, with the cost of a pound of protein in each, and then the purposes for which the feed is given, it is possible to make a more intelligible selection than on the basis of cost only. If dairy cows are to be fed, then clearly gluten or cottonseed meal would be chosen, and particularly would this be true if grass hays, silage and corn stover were at hand in abundance.

**Using Judgment in Getting Protein.**—In purchasing protein judgment must be exercised in selecting the carrier of it. For instance, corn is cheaper than bran on the basis of total digestible nutrients, but if for the dairy, bran should be purchased rather than corn, because the bran contains nearly twice the amount of protein. Cottonseed meal contains just about five times the quantity of digestible protein that corn does. If the two could be purchased at the same price per pound of digestible nutrients, cottonseed meal would be many times more valuable than corn, because of the very much larger quantity of protein.

**Roughage Materials** should be as carefully selected as the concentrates. It is often advisable to sell one kind of feeding stuff and purchase one or more kinds in exchange. It is usually economy to

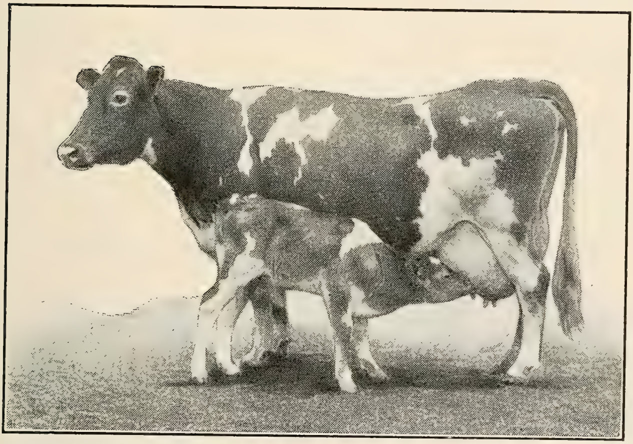
sell corn and oats and make an outright purchase of cottonseed meal, gluten meal and bran, if dairy cows are to be fed. Often one can sell roughage materials to good advantage and secure others that contain more of the constituents desired, and in so doing the amount of concentrated foods can be cut down.

If the feeder uses corn stover and timothy hay, he will necessarily be forced to balance his rations with concentrated materials. On the other hand, if he uses cowpea hay, alfalfa or clover hay in the main for roughage, the necessary grain material will be small. In many markets timothy hay is sold for $20 to $30 a ton and up, while cowpea hay, alfalfa and clover sell for $20 a ton and under. You see at once that the legume hays are the most economical, for they contain several times more digestible protein than timothy. It is to the feeder's advantage to dispose of the timothy, often, and with the same money purchase the legume hays. The saving in corn and bran or other concentrates will be clear profit. Of course, the desirable way is to grow the legumes in abundance; then, with much silage, the call for purchased grain, or concentrates, will be of little consequence.

# CHAPTER XIV

## FEEDING YOUNG ANIMALS

**Food Requirements of the Young.**—Young animals require food that will form tissue and bone rapidly. Hence, nitrogenous and mineral substances must be supplied abundantly; and from sources that appeal to the taste and that are easily digested. In this supply milk comes first. It is nature's choice,



THE NEWLY BORN REQUIRE COLOSTRUM

When an offspring is born, the dam for a period of a few days secretes colostrum. This milk acts beneficially on the digestive tract.

and for young animals is the most desirable. It contains the necessary nutrients in a properly balanced form, in most cases is liberally provided by the mother, and in all respects is the ideal food to start the offspring on its way to maturity.

Milk contains not only protein and ash, but fat, sugar and water also. But the protein of milk is in a much larger proportion to the fat than is the case with other food that meets all nutritive requirements at later periods of growth. And at the time of birth this is particularly the case. When a calf, for instance, has just been born, the dam for a period of a few days secretes *colostrum.* This fluid, or first milk, is of a very concentrated description. It is yellow or yellowish in color, is of a viscid nature, possesses a peculiar smell and salty taste. As it is slightly purgative, it acts beneficially on the digestive tract, and, if the young is to be started forward favorably, it should not be withheld.

**Colostrum.**—Compared with ordinary milk, colostrum is rich in protein and the mineral substances, but relatively lower in milk sugar and fat. In five days to a week after birth the secretion of milk increases, and the composition gradually changes from colostrum to ordinary milk. The composition of cow's milk at calving and at a later period shows the higher food value of the first milk. This will be observed below:

DIGESTIBLE NUTRIENTS OF COW'S MILK IN 100 POUNDS

| Kind | Dry matter | Digestible nutrients | | | Nutritive ratio |
|---|---|---|---|---|---|
| | | Protein | Carbohydrates | Fat | |
| Colostrum ... | 25.4 | 17.6 | 2.7 | 3.6 | 1:0.6 |
| Ordinary milk | 12.8 | 3.6 | 4.9 | 3.7 | 1:3.8 |

From this comparison we note the large amount of dry matter and protein in the first milk as against ordinary milk. With both kinds there is almost perfect digestibility. The proportion of the protein or tissue formers to the fat or heat producers is much higher in colostrum than in ordinary milk, and in each more than in most vegetable and commercial foods. The nutritive ratio of colostrum is in the proportion of one of protein to six-tenths of fat and sugar, and of ordinary milk of one of protein to 3.7 of fat and sugar. This difference indicates the rapid change that takes place in the milk soon after the birth of the offspring. The protein diminishes, while both the fat and the sugar increase.

**Ration Should Be Changed as Age Advances.**—As young animals grow older and consequently enlarge in size they call for increasing amounts of the heat and fat-producing elements. This is illustrated in the table below, and is based on 1,000 pounds live weight:

FOOD REQUIREMENTS OF GROWING CALVES

| Live weight of calf | Dry matter | Protein | Carbo-hydrates | Fat | Nutritive ratio |
|---|---|---|---|---|---|
| 150 | 23 | 4.0 | 13.0 | 2.0 | 1:4.5 |
| 300 | 24 | 3.0 | 12.8 | 1.0 | 1:5.1 |
| 500 | 27 | 2.0 | 12.5 | 0.5 | 1:6.8 |
| 700 | 26 | 1.8 | 12.5 | 0.4 | 1:7.5 |
| 900 | 26 | 1.5 | 12.0 | 0.3 | 1:8.5 |

This table shows the alterations in the rations of a growing calf from shortly after birth up to a period of a year or a year and a half. As the calf grows

YOUNG CALVES SHOULD BE KEPT STEADILY ON THE GAIN

older, adding age and weight, the nature of the ration changes through decreasing demands for protein and in increasing demands for the carbohydrates. In its early days a calf takes on weight very rapidly. Compared with its weight the amount of food consumed is very large. Often a small calf will gain in weight as fast as a mature steer ten times as big. Of course the flesh is less solid, the increase is of a more watery nature, and the food consumption in proportion to the size of the animal is enormous.

**Nature Widens the Ration.**—During the babyhood of the calf, or of any other animal, not much exercise is taken; hence, less of the heat and energy materials are called for; but as this condition changes, there arises a need for more of the carbohydrates and fats to provide for mechanical work both within and without the body. As these are supplied the ration takes on more of each and decreases proportionately the protein.

Nature supplies the needed carbohydrates by creating an appetite for grass and roughage materials. Just after birth a calf, partaking of colostrum, is fed abundantly with protein; in a few days this gives way to ordinary milk, with less of protein and more of sugar and fat; and then a week or two later the call of nature is further met by means of the nibbles of grass or grain wherein is stored still larger quantities of the carbohydrates and fat to meet the cravings occasioned by exercise, energy and mechanical work. In this manner every offspring gradually adjusts its food to its needs and very largely balances its own ration.

**From Whole to Skim Milk.**—It is not uncommon to give whole milk to a young calf for a short period after being removed from its mother. The period, during which whole milk is supplied varies more or less, depending on the value of the calf or the use to which milk on the particular farm is put. Sooner or later, however, skim milk is substituted for the whole milk. If the substitution is gradually made, and if some additional food is provided, no objection to the change will arise. But too frequently skim milk is abruptly substituted, and it only is fed. This is bad practice.

Skim milk contains little if any fat; consequently, the young animal is deprived of this nutrient and will not thrive in a satisfactory manner. Nor will increasing the quantity of skim milk help. Death will ultimately follow if the skim milk ration is continuously fed and not balanced by means of some substitution for the fat removed from the milk. Below are shown the digestible nutrients in whole and skim milk:

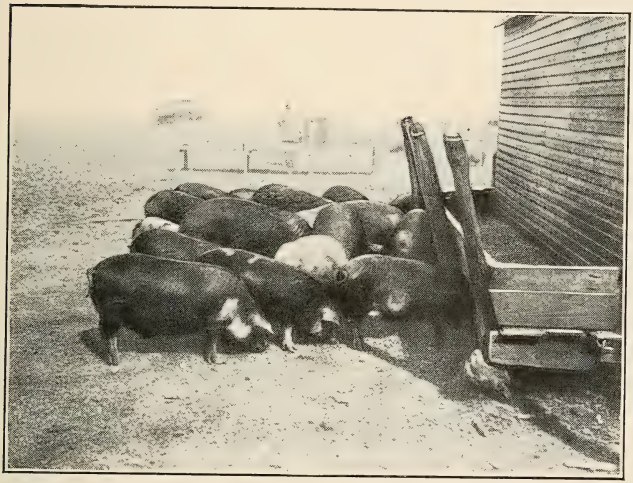
WHOLE AND SKIM MILK COMPARED

| Kind | Dry matter | Digestible nutrients in 100 pounds | | |
|---|---|---|---|---|
| | | Protein | Carbohydrates | Fat |
| Whole milk ... | 12.8 | 3.6 | 4.9 | 3.8 |
| Skim milk ..... | 9.6 | 3.1 | 4.7 | 0.2 |

When the fat is removed by skimming and the remaining liquid fed exclusively, the calf or the pig develops slowly, shows dissatisfaction with the food,

and is less thrifty generally. This condition is overcome by supplying shelled corn or oil meal in addition to the skim milk. Not only will a more rapid growth soon be apparent, but gains will result more economically.

**Little Trouble with Suckling Animals.**—With colts, pigs and lambs during their suckling age there



GATHERING UP WHAT THE STEERS DROP

If pigs are permitted to follow cattle and horses much waste food will be utilized. Often no additional food is required than what the pigs themselves gather in the feed lots.

is usually no problem at all. If the mothers are properly supplied with food the regular course will be taken and each will adjust its ration to its own individual needs, provided grass or grain is available. This is likely to be the case as the offspring feeds with its dam. It will soon learn to eat at its mother's side.

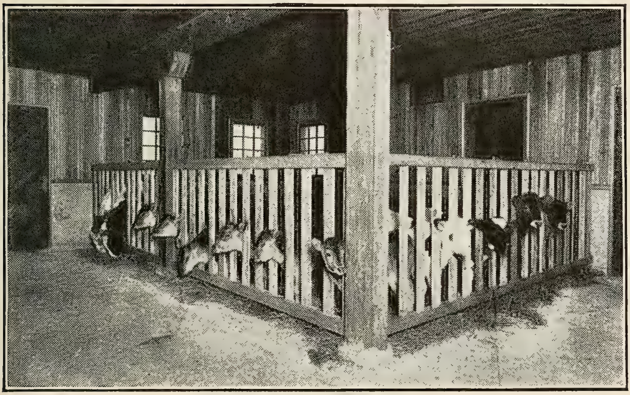
Calves, on the other hand, present a different case. Their original food has a great commercial value; and whole milk for the market or for butter is too valuable to be used as a feed for average calves. Consequently, milk is not set before them until after the butter fat has been removed.

A practical way is to feed the new born calf whole milk for a week or ten days, then gradually change from whole milk to skim milk. During, or following this change, the young calf will begin to eat corn and oil meal, and never will notice the substitution either in temper or development. With oil meal worth a cent and a half a pound, and butter fat worth 25 or 30 cents a pound, it is apparent that it is a heavy loss to feed butter fat when oil meal is as wholesome and nutritious.

**Calf Feeds.**—Many especially prepared calf feeds are on the market as substitutes for milk or for butter fat. Many of these are excellent and perfectly satisfactory. Their one objection is their cost. A ton of prepared calf food may cost $50 to $100, but practically all of the substances were obtainable at $20 to $35 a ton. When linseed oil meal, boiled flax seed, corn and pea meal, etc., are available, it is possible for every farmer to secure his own supply and to obtain a satisfactory substitute for the butter fat that he removes from his milk.

**Feeding the Dairy Calf.**—Opinions vary as to whether it is best to remove the calf from its mother at once or to wait until some days after birth. It is becoming more and more a custom to remove the calf early, within two or three days at the most.

The calf is allowed to nurse at its mother's side at first. It is then removed to a box stall or an open lot away from its dam, and allowed to get hungry. Then, with three or four pints of its mother's milk, it is taught to drink. This teaching may run through a period of two or three trials. Two or three feeds a day should be given, three being better than two. If the calf is not very strong, four feeds are desirable.



READY FOR THEIR BREAKFAST

This simple contrivance is much esteemed where many calves are fed and raised. Each gets its own ration without fuss, confusion or fight.

The milk used should be from the mother and not from another cow, because it is the colostrum that is desired; and this milk should be fed while warm from the cow. This should be kept up until the calf has a good start and is drinking well. Some dairymen begin to change from whole to partly whole and skim milk in a week or ten days, while others

continue the whole milk for a period covering two or three weeks. Some time between ten days and three weeks skim milk may be substituted for a part of the whole milk. To the allotment of whole milk add about one-fourth more of skim milk and keep increasing the skim milk for a week or ten days, until the whole milk has been entirely displaced by skim milk. When the skim milk has been started, a teaspoonful of linseed oil meal may be mixed with a half cup of warm water, then added to the milk, which is, of course, partially skim milk. The calf at this time will be taking two quarts three times a day.

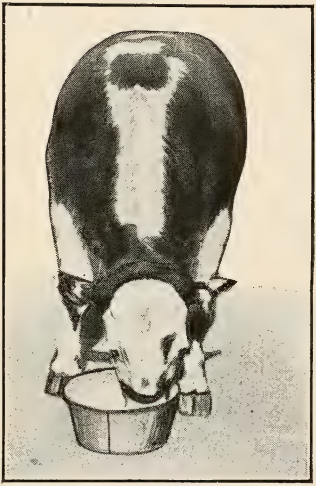
It is worth while to be careful not to overfeed. Overfeeding on skim milk always stunts a calf. During this early feeding period not more than three quarts should be fed at a time and three feeds a day should be given.

The oil meal is to be gradually increased until, in the course of a few months, a half pint is fed daily. Some dairymen get excellent results by using a flaxseed jelly in the skim milk. To make this jelly, soak whole flaxseed in hot water. Many calf raisers think this food far superior for young calves to any calf meal used as a substitute for milk. The best substitute for the flaxseed is linseed oil meal.

When the calf is two or three weeks old a little whole corn and oats in the box where the calves can get at it will be eaten and relished. The calf will soon take to hay. The aim should be to keep the calf growing steadily and in a thrifty condition. Spring calves can soon be turned in a pasture lot. If

fed the skim milk and the cream substitutes, they should show steady growth and plenty of thrift.

After such calves have reached the age of four to six months, the skim milk may be dropped out of the ration, but the grain concentrates like oil meal, corn and oats, should be continued, even increased slightly, and fed in conjunction with pasture grass or the legume hays. During the first winter let these hays be abundantly fed, so as to develop large stomachs, and to furnish plenty of protein and the ash materials.

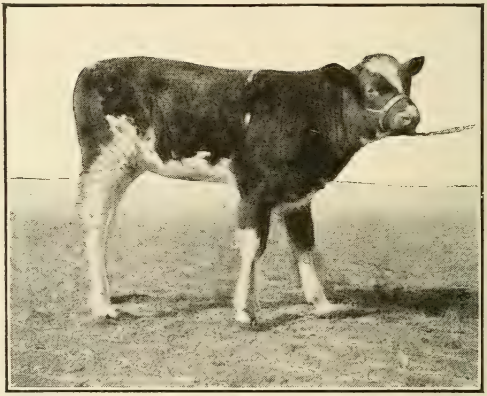


BEEF IN THE MAKING

The new idea in beef production is to grow beef and not to fatten cattle.

**Feeding the Beef Calf.**—In some sections of the country calves are either vealed or saved for beef, and yet the cows are managed so as to get the most milk possible either for sale or for butter. Best results are obtained when veal calves are given all of the whole milk they will use. Many allow the calf to stay with its mother during a period of three or four weeks, taking all of the milk that the mother gives. In addition, some grain is allowed, consisting of oil meal or flaxseed and corn. When disposed of as veal calves, the mother is put in the herd and

milked thereafter. This practice is permissible with cows of a poor grade. It is injurious in high milk production, and inevitably leads to the destruction of the herd, because many of the good dairy calves are vealed and forever lost as dairy prospects. If calves are allowed to suck their dams for as long a period as required for making good veal, the value of the cow as a milk producer is somewhat lessened.



Bred for Beef

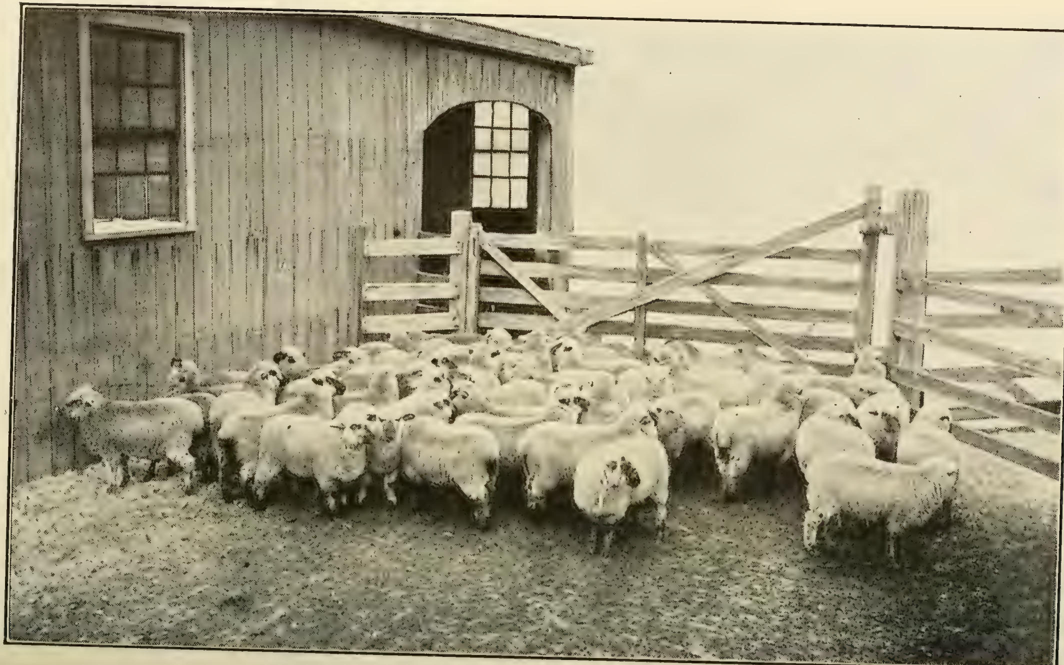
Th s pure-bred Shorthorn calf was left with its mother for a week. After that time it was fed whole milk, then whole and skim milk mixed, then skim milk and oil meal.

Objection to the practice of first milking the cows and giving the whole milk to the veal calves is raised because of the labor expense. Some farmers meet this by removing some of the butter fat and providing substitutes as previously described for the cream removed. Where calves intended for beef stock are removed from their mothers cream substitutes can

be given in addition to skim milk, as described for dairy calves. They should be fed so as to obtain quick development. Larger quantities of concentrated grains are admissible in proportion to the roughage materials than where whole milk is fed; yet the aim is not to fatten this young stock, but to grow beef. This means gradually to widen the ration, basing it on good grass, skim milk, oil meal, and corn, and later, on silage, if available, and a reasonable amount of hay, the legume kind preferred.

Where beef is raised exclusively, particularly on the western ranges and in beef herds produced from beef breeding stock, calves are allowed to suckle their mothers until naturally weaned. If allowed the run of the pasture with the mother, little, if any, food is given in addition to what is obtained by suckling the dam and by grazing. These beef dams are not heavy milkers as a rule; consequently, the food supply from the milk is much smaller than if the same practice were followed in the dairy herd. As weaning time approaches either an abundance of succulent grass should be available, or else substitutes should be provided in the way of concentrates and hay. During their first winter beef calves raised in this manner, either while on or off the cows, should be given grain, silage if available, and good bright hay. The quantity of each will vary with individuals. The aim should be to provide the protein liberally. If good hay and silage are available the proper balance of food material will follow.

**The Feeding of Lambs.**—At birth the main thing is to see that the lamb gets its mother's milk. The

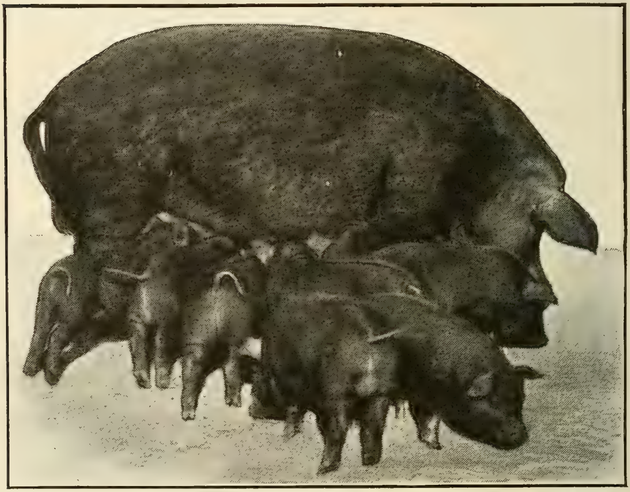


THRIFTY LAMBS FOLLOW GOOD CARE AND WISE FEEDING

ewe's udder should be examined to see that it is in a healthy condition. If the ewe is receiving the proper kind of food and her udder is doing its work, no further attention is necessary. From the time the lambs are dropped until taken from the flock they are dependent on the mother ewe both for milk and for companionship. If the lambs are taken from the ewe and compelled to suffer from hunger and lonesomeness, it is no wonder that they bewail their condition and shrink in flesh. The good flock-master avoids this, because it is inhumane and always acts as a physical shock that requires some time for recovery.

The mother ewes should be given some grain food, in addition to pasture or other roughage, during the period the lambs are with them. If the lambs are thrifty, they will soon learn to eat of the same kind of food. Such lambs, being thrifty, are always good eaters and make but little fuss when removed at weaning time. It is good practice to prepare for weaning. Prior to weaning, teach the lambs to eat some food that will take the place of the mother's milk better than the grass of the pasture. Get the flock into an inclosure where they will be comfortable after having fed on grass in the morning, and give them a light feed of some mixture of concentrates like oats and bran, half and half, or oats and bran with some oil meal added. The ewes will enjoy a light feed of this morning and night, and the lambs will learn to eat with them. When the lambs have learned to eat these concentrates in the inclosure, the ewes may be separated from the lambs.

When the day of separation has arrived, get the flock in the inclosure earlier than ordinary, feed, and then hold until nearly time to turn out. Now sort the ewes, then feed the lambs, and take the ewes to some distant field out of hearing of the lambs. After the lambs have had a good feed of grain turn them back



LARGE LITTER OF VIGOROUS PIGS

Creeps for young pigs in which they may go for slop food are desirable. Both mother and pigs benefit.

to their old pasture ground, and they will go to picking up grass at once. The lambs should be taken up each day, fed a fairly liberal portion of grain, be given access to all the water needed and plenty of grass, and they will make good growth without further bother.

**The Feeding of Pigs.**—The sow while nursing requires liberal feeding, as the rearing of a large litter is a severe drain on her system. Skim milk, butter milk, bran, shorts, ground oats, wheat and barley, with a run on pasture grass, will meet the situation. No care or attention will be needed to get the little pigs to drink when two or three weeks old. A good method is to provide a shallow, flat-bottom trough in a small inclosure in one corner of the lot where the sow is fed, allowing the young pigs access to this at will, but where the sow cannot reach it. For the first day or two a little fresh milk can be used; afterwards give sweet skim milk, properly warmed. If skim milk is not available, then middlings or shorts mixed in a thin slop are a good substitute. This can be fed twice daily.

The pigs should not be weaned abruptly, because of the injury that would result to the sow. There is a large flow of milk, which should be dried up gradually. It is not a good plan, either, to remove some of the pigs, allowing the remaining ones to stay with the mother a few days or a week or so. This is admissible, however, if part of the litter has profited at the expense of other members. In case this is so, the larger ones can be removed after they have become satisfied with their slop ration, and the less thrifty ones kept back to dry off the sow. Weaning should be done gradually; then there will be no sudden check either to the pigs or the mother. If the sow is fed a spare diet consisting of a little dry grain or given the run of an old pasture, the

secretion of milk will be arrested and both sow and pigs will adjust themselves to the new order.

When the young pigs have learned freely to take slop made of shorts or middlings and skim milk, they are ready for weaning. This usually takes place at seven to ten weeks of age. If skim milk is not available, then the longer the pigs remain on

Resting in the Pasture Field

The brood mare may be worked practically up to foaling time. After foaling for 10 days or two weeks she is entitled to ease and rest. In summer the pasture or paddock is the best place for her and plenty of fresh water and grain should be supplied.

the dam the better. In no case should they be weaned until they take food freely apart from their mother. After being weaned, give them access to a good pasture and a grain slop of middlings, shorts or corn meal twice daily. The amount of meal fed will depend upon the condition of the pasture.

Young clover, or a mixture of young timothy and clover or alfalfa, will meet the requirements excellently. The custom of preparing grazing lots of cowpeas, rape, peanuts, sweet potatoes or rye is growing, and where this method is followed the cost of producing pork is materially lessened. At wean-

AN INEXPENSIVE COLT CREEP

Young colts, on pasture with their mothers, may be given grain by means of some contrivance as this.

ing time the ration must contain a liberal amount of protein, but as age advances this will decrease proportionately, and the pigs, if admitted to good pasture, will grow rapidly and thrive as they should.

**Feeding the Foal.**—Until the foal is a month old it ought not to get wet nor have a damp bed. During this time it will obtain its food largely from its

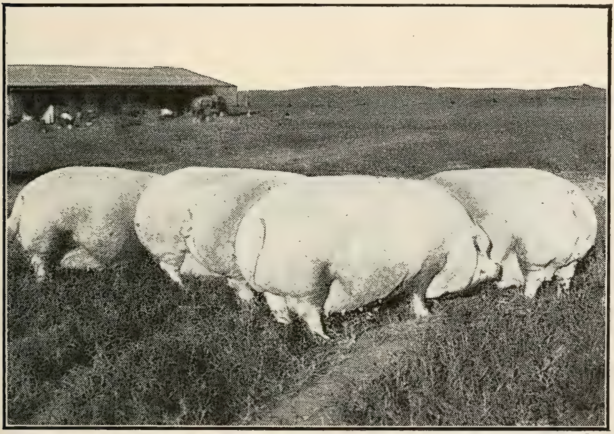
mother as milk. For a week or ten days after birth the mother should be given rest in the pasture field, after which she can be started in again on light work. Ordinarily, it is best to train the foal to remain in its stall while the mother is at work. When the mare is started in at work again, the foal should be allowed for a while to have its mother's milk at least once in the forenoon and once in the afternoon, and to remain at its mother's side during the noon hour, and from quitting time in the evening until the mare is put to work in the morning.

If allowed to stand at its mother's side, the foal will soon eat of grain in the manger, and in this way learn to eat both grain and hay, in addition to grass in the pasture field. By weaning time the foal should know how to eat what it subsequently will be given. Corn, oats, bran, and oil meal make an excellent mixture and can be given in equal parts, though at first only in small amounts. Grass is an ideal food when supplemented with oats or with the combination just mentioned. The weaning should be done gradually; then neither foal nor the dam will suffer. After weaning, increase the grain and provide good bright hay for roughage. Handled in this manner, the foal will go through the winter nicely and when turned out to pasture in the spring will show thrift and make rapid growth.

CHAPTER XV

# THE FEEDING OF BREEDING ANIMALS

The excessive feeding of breeding stock is harmful; indeed, more so than when animals are underfed. This is especially true when the feeding ration contains an overabundance of carbonaceous foods. When such are supplied to mature breeding stock,



Too Fat for Good Breeders

Breeding stock should be thrifty, but not excessively fat. Otherwise their breeding qualities will sooner or later be impaired.

the animals often become very fat, and are not as prolific as they otherwise might be. The adult animal, if properly nourished, neither gains nor loses in weight. It requires food for the repair of tissues, to maintain its regular supply of hair, wool and

horn, and to produce heat and mechanical work by combustion of the food in the body.

In addition, breeding animals must have food enough to provide for the growth of the fetal young. This means blood and tissue for every part of the offspring. Carbohydrates and fat cannot assist in providing this material. It must come solely from the protein of the food. Consequently, every pregnant animal should be given considerable protein in her ration, both for her own use and for the developing progeny.

**Feeding the Dairy Cow When Carrying Calf.**— After calving, and then for a period of several months, the good dairy cow drops off in flesh, even though liberally supplied with food. She should never be fat as that condition is known in respect to the beef cow. After she has caught her gait in milk production, her weight is maintained for a considerable period, and if the food supply is still liberal, she will gain in weight and flesh. Ordinarily, the rations of the dairy stable are satisfactory both for milk production and for the support of the fetal calf.

Heavy concentrated grains may be injurious, hence caution will not be out of place if taken at the time the cow approaches parturition. During the latter part of her lactation period concentrated feeds like cottonseed meal or gluten meal should be lessened or discontinued altogether and food like wheat bran or some of the laxative commercial feeds given instead. Some grain will be necessary at this period in order to maintain the milk flow, even though it

has become lessened naturally in quantity. This grain should be of a nature that will tend to make milk and that will at the same time act as a good carrier of mineral substances. Thus not only the cow but also the developing offspring will benefit.

Just before parturition laxative foods are to be preferred. Of course, nothing is better than good pasture grass, and if cows have the run of a pasture field from spring to winter little trouble will be met with at calving time. If, however, the calves are dropped during the winter when pastures are no longer available, the next best thing is silage for succulence, and if silage is not available, then molasses, molasses feeds, or the beet pulps and roots. During the winter cows either in milk or carrying offspring should be liberally supplied with the legume hays like clover, alfalfa or cowpea, so as not only to provide an abundance of protein but of ash material as well.

While it is not desired that the dairy cow be fat, still she should carry a reasonable amount of flesh. The production of fat cells in the body is, to a certain extent at least, at the expense of milk cells; therefore the dairy cow with beef tendencies is usually not a profitable milk producer. Since milk is not an object of great importance with the beef animals, bloom, quality and flesh are desired in this class of stock. To be profitable the dairy cow should be in milk ten or eleven months each year. The cow that goes dry after five or six months of milking would be more profitable for the farmer in the fattening lot than in the dairy herd. Two or three

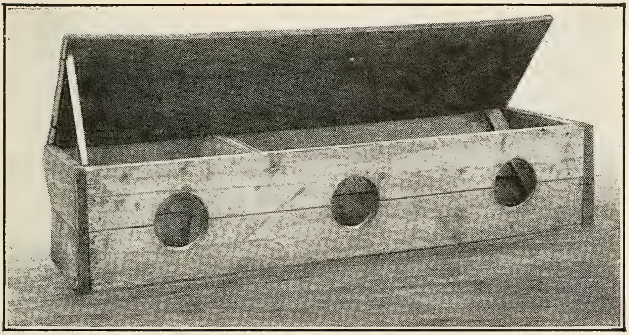
months prior to calving, the dairy cow or the beef cow should receive daily a pound or two of wheat bran, four or five pounds of alfalfa, clover, or cowpea hay, for needed protein and the ash constituents. This is particularly needed during the winter and during the summer or the fall when the pasture grass is short or withered.

**At Calving Time** the cow should be put off by herself. Bran, clover, alfalfa, or cowpea hay, together with silage or some other succulent food, should compose the daily ration. After calving, cut out the ration entirely for a day or so; feed only a little bran and succulent food. The quantity of food may be increased from the second day gradually until the cow is placed on her full ration. It is not well to be in too big a hurry to get the cow on a full ration or to bring her up to the full capacity as a milk producer. It is often a wise practice to use a full month to get the cow on full feed and to her production capacity.

The beef cow usually is given the range of the field in which she may drop her calf. She is placed under conditions more natural to her, and hence, usually, will take care of herself and her offspring. If pasture is abundant, supplementary feeds will not be required; but if she is an important breeding cow herself, in high breeding form and flesh, and if, because of her breeding, it is desired to secure the quickest and fullest development of the calf, additional food in form of concentrates may be given to advantage. If the herbage is scant or otherwise insufficient or improper, a grain ration should be pro-

vided. In either case the ordinary commercial feeds like cottonseed meal, the glutens, wheat bran, oil meal or corn may be furnished singly or in combinations, depending on the cost or the ease of obtaining them.

**The Brood Sow.**—Corn has been connected for so long a time with hog feeding that it still holds a high place as a food for the brood sow. To a certain extent this practice is wrong, but though many lead-



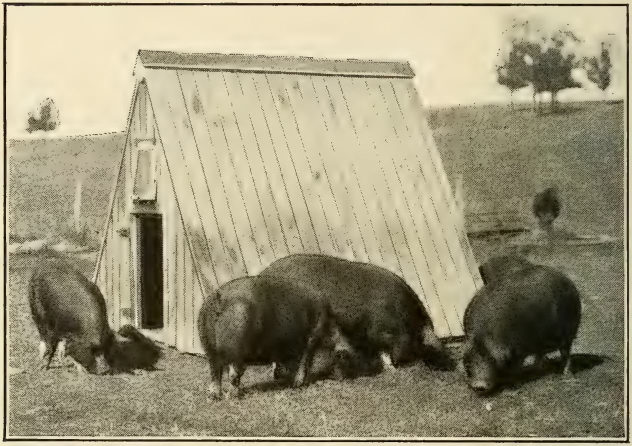
FEEDING BOX FOR ALFALFA HAY

Hogs relish alfalfa during all seasons of the year. In winter dry hay may be placed in a box as here shown and much less will be wasted than when thrown on the ground or placed in racks.

ing hog men caution against the heavy use of corn, they nevertheless do resort to it more or less. This is partly because in the important hog sections corn is always available and usually abundant as a hog food, and because it is home raised and seldom refused or rejected.

Food of a more protein nature should be fed the sow previous to the time of dropping her pigs and

while she is suckling them. This does not mean that corn should be cut out of the ration altogether. In sections where corn is not freely produced, and where its commercial value is high, substitutes are more generally provided and the objections to its use are not usually met.



A PORTABLE HOG HOUSE

Here is shown a hog house that can be moved to various parts of the field, insuring cleanly quarters and new feeding grounds. Both are items of great importance in hog raising.

The food of the brood sow should be similar to that given the dairy cow, particularly the grain part of the ration. Even silage is good, as are also alfalfa and clover hay. To those unaccustomed to the use of alfalfa or clover hay it may seem impossible that the brood sow would use either to any great extent. Nevertheless, the consumption of such is practically as great as when either is fed to horses or cows.

Bran slop makes a very desirable food, as do also middlings and shorts, and should be fed both before and after the pigs have been dropped.

**At Pigging Time,** the sow should not be disturbed and her ration should be diminished for a day or two. A thin slop or clear water should be set in her pen and nothing done to excite or disturb the sow in any way. Brood sows should be accustomed to handling

MAKING PORK FROM RAPE
This forage crop is gradually extending its boundaries, and, while useful for all stock, is especially prized as a green pasture for hogs.

and at pigging time should admit the owner or an attendant to give quiet assistance when necessary. If the weather is cold some provision for heating may be advisable, or the newly born pigs may be removed to a basket after having been carefully wiped and dried, and after having fed on the milk that by this time has been secreted. It is important that the pigs get the first milk soon after birth. Otherwise their strength soon declines.

In a day or two the food supply should be increased. It should consist of milk-stimulating and milk-producing foods like middlings, shorts, gluten, linseed oil meal, pea meal, skim milk, etc. A little corn or corn meal may be given, but this should be limited.

**Exercise for Brood Sows.**—See that the brood sows take exercise and that they get succulent food. It is doubtful if any other factor in hog raising has brought about quite as much injury as the practice of placing brood sows in little pens, preventing them from getting juicy roots or green foods and cutting off their opportunity for exercise entirely. The run of the pasture field, or in the winter of rye or wheat lots, or in fall of harvesting peanuts, artichokes, cowpeas, or of cleaning up old meadows, all add vigor to the sows, largely wipe out the cost of keep, and increase the vitality of the coming offspring. The best mother is one that supplies a heavy flow of milk. To do this she must be healthy, strong, and be liberally supplied with food. From well fed brood sows, therefore, usually come the healthiest and quickest maturing offspring.

**The Brood Mare.**—There is no objection to working the brood mare or of exercising her right up to foaling time. Liberal feeding on oats, or bran, balanced with corn and hay, will furnish a satisfactory ration for the mare before and after foaling. The same precaution should be taken to diminish the food supply when the colt is born as when the calf is born. The mother at foaling time is in a feverish condition, and weak also. She should be fed only what is needed for appeasing the appetite.

Succulent grass is cooling and is never objectionable. The grain allotment for a day or two, however, should be small and should consist of ground oats or wheat bran, or both, without corn.

After a day or two the milk secretion will become active and the mare will recover her appetite. For a week or ten days she should have complete rest, preferably in a paddock, or the run of a pasture will

Rounding Them Up in the Pasture

do. When put to work at the end of this rest period, her tasks should be of a light nature at first, not of long duration, and not in excessive heat or sunshine. Gradually increase the rations until a liberal supply is given so as to meet the demand occasioned by work and the production of milk.

**The Ewe.**—In localities where the ground remains uncovered during much of winter flock masters are fortunate because of the pasture and the tough sod on which the sheep can at times be grazed. Lambs will not come large and strong unless the ewes have been properly fed, properly

housed, and properly exercised. Where pasture is not available during the winter, no feeds are quite as good as alfalfa and clover hay. Either may be fed once or twice a day. If but one feed of either is given, then good corn stover, or millet, or even oat straw, may be used as a roughage for the other feed. Peas and oats, vetches, and cowpea hay, are all excellent roughage feeds for breeding ewes.

When thus supplied with good fodder, the ewes do not need much grain until toward the approach of the lambing season. They will be in better condition, however, at lambing time if they have been fed a small quantity of grain previously. Whole oats are very suitable for them, but what is better is a little bran or oil cake along with the oats. Neither the bran nor the oil cake is necessary, but either or both will add to the efficiency of the ration. Field roots are also excellent, but before lambing it is not necessary to feed more than two or three pounds a day. If roots cannot be had, and corn silage is available, it will be in order to feed silage at least once a day. Either clover or alfalfa goes admirably with silage.

Sheep will take ample exercise if given the freedom of one or more fields when the snow is not deep or altogether absent. It is only when snow is deep and the ewes are unable to move about that they are in danger of becoming too sluggish. The more highly they are fed, the more sluggish they become. To avoid this, it may be necessary to put some of the feed in racks some distance away from the shed, but preferably in a secluded and protected spot. The

ewes will find their way to these racks if the feed is enticing, and thus get needed exercise.

If the lambs are to come early, the ewes should be in the pink of condition, or they will not be able to keep the lambs growing well until grass comes. The grain supply should be small at first, then increased gradually. Very many lambs are weakened before birth by the injudicious feeding of the mother.

**At Lambing Time.**—After the lambs begin to come let the grain supply be reasonably generous, so as to provide an ample milk supply. This will follow if the roughage materials suggested above or others similar to them are given. Milk-stimulating concentrates, which mean an ample amount of protein, are positively indispensable if a generous milk supply is to be obtained. A method followed under this general plan will be certain to bring sturdy, vigorous lambs. These will grow rapidly, the mothers will not drop off in flesh materially, and the milk will be abundant and nutritious for the sturdy and greedy offspring.

## CHAPTER XVI

# FEEDING FARM HORSES

**Food Requirements for Horses.**—Work horses require protein to repair the broken-down tissues; fats and carbohydrates to produce heat and energy. The harder an animal works, the more food required. The Wolff-Lehmann standards for feeding farm horses are shown in the table below. They indicate the amount of food required per 1,000 pounds live weight and are for horses when doing light, moderate and heavy work.

WOLFF-LEHMANN STANDARDS FOR HORSES

| Nature of work | Dry matter | Digestible nutrients | | | Nutritive ratio |
|---|---|---|---|---|---|
| | | Protein | Carbo-hydrates | Fat | |
| Lightly worked .. | 20 | 1.5 | 19.5 | 0.4 | 1:7.0 |
| Moderately worked | 21 | 1.7 | 11.0 | 0.6 | 1:6.2 |
| Heavily worked .. | 23 | 2.5 | 13.3 | 0.8 | 1:6.0 |

**A Fundamental Principle in Horse Feeding** is to use a relatively smaller quantity of roughage and a correspondingly larger amount of concentrates than for bovines. The kind of work to which horses are put calls for the least possible load on the digestive organs, which even in the heavy draft breeds are small, particularly the stomach. Hence, the food

of the horse should be nutritious in quality, be supplied frequently, and in comparatively small quantities.

**Nature of Food.**—The food, of whatever variety—and it may include a wide range of feeding materials—must be clean, wholesome, and sound; but beyond this no specific rules can be laid down, except that, generally speaking, reasonable attention should be given to the digestible nutrients, in that they should

Well Bred and Well Fed

bear the proper proportion one to another. The amount and character of the food must vary with the size of the horse and the purpose for which it is used, the climate and the season, and the section in which it is used.

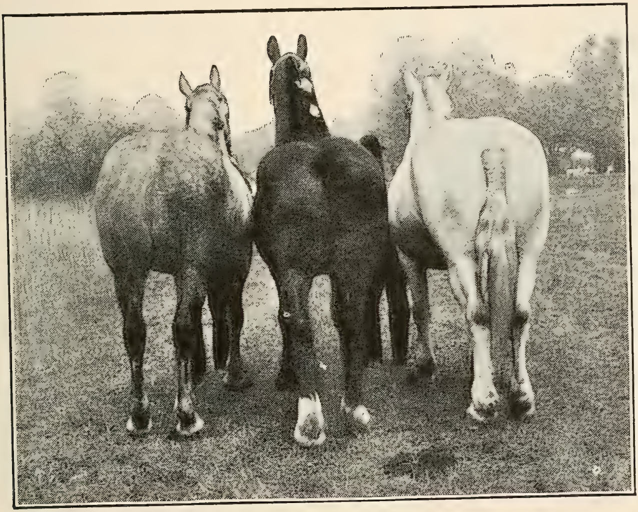
**Character of Food.**—The horse feeds on a wider range of food substances than is popularly supposed. In Arabia, where stamina and sinew are famous, the principal food is barley and scant herbage; in

Ireland it is dried fish mainly; in England hay, oats, and beans comprise the food supply largely; on the continent of Europe, rye, barley and inferior wheat make up the grain portion of the rations; while in this country many feeding stuffs, covering a wide range of roughage and grain, find their way into the feed mangers and satisfactorily keep the horse stock in health and vigor.

It is not so much the kind of food, but the purity and character, that count. Moldy hay and grain cause many of the ills that the horse is heir to and imperfect methods of preparation and curing have cast an odor of unpopularity on many meritorious feeds that, if properly handled, would be eagerly sought because of their ease of production or relatively less cost when compared with the standard horse feeds of each particular section.

**Requirements for Work.**—Naturally the work demanded of a horse will influence the choice and amount of food its caretaker gives it. The race horse or the roadster, fed on coarse roughage and little grain, will be greatly handicapped if in competition with another that has been supplied with nutritious and appetizing concentrates and little rough fodder in the ration. In winter the draft horse can subsist very nicely on hay or fodder and little or no grain, providing the work is light and the hours of labor few. But this same horse, when put to hard labor in spring and summer, at plow, cultivator or harvester, will demand less hay and more grain if the highest efficiency is to be had.

Farm work is usually not of a strenuous nature, even in the busy season. On some days and during some periods the work is light and not infrequently there are many days of rest. At such times less food should be given, but the feeding should be done



EQUAL TO ANY TASK

Heavy farm horses require nutritious food when at severe work. The grain portion of the ration should increase or decrease in accordance with the severity of the work.

in such a fashion as to keep the horses in good work form and in thrifty condition.

It is believed by many feeding experts that the protein requirement as called for in the feeding standards is unnecessarily high. Many good rations have been studied under practical test, the efficiency of which is well known, and the conclusion is un-

questioned that with our feeds and under our work conditions less protein is required than what the Wolff standards set forth.

Quite recently Kellner, the celebrated German authority, as a result of his experiments, stated that the large quantities of protein called for in the old standards are unnecessary for working animals, there being required only enough for the general maintenance of the animal machine and to insure the complete digestion of the food. To bring this about the nutritive ratio of the ration can range from one pound of protein to eight or even ten of carbohydrates and fat.

This view is substantiated by many tests in this country. Hence the conclusion that two pounds of protein will answer the requirements for that nutrient for a 1,000 pound horse doing heavy work can be accepted as both conservative and wise because of the less expense at which energy can be obtained. Of course young animals not fully matured will fare much better when rations are prepared containing more protein. In cases like these, and where horses are put to very severe work, the older standard for protein is to be recommended.

**Giving Water.**—In a state of nature horses feed upon juicy herbage and drink at pleasure only pure water when that is available. No animal is more delicate and fastidious about its drink than the horse, and often these animals will suffer agonies of thirst rather than quench it with impure, stale or tepid water. Water should be given frequently and in small quantities.

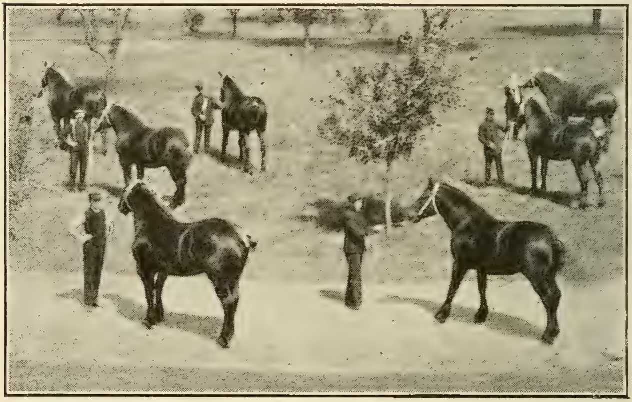
Some horses require more water than others, the quantity varying with the nature and amount of the ration, the propensity to sweat, and the season of the year. In a test at the New Hampshire station the amount of water drunk by five horses was recorded, showing a variation of from 25,895 pounds to 32,997 pounds in the course of a year. Stale or foul water from a neglected cistern is unfit for a horse and will be refused, except in case of extreme thirst or when no other kind is provided.

The custom of not giving horses a drink during the forenoon or the afternoon when working in the field is frequently condemned but generally followed. In our larger cities horses are often never given water between morning and evening. This is cruel, of course. The good horseman will be more thoughtful of these dumb beasts intrusted to his charge. Not only should the horse be permitted to drink his fill at noon, but during hot weather in the dusty fields a cool drink should be provided also.

**Order of Hay, Grain and Water.**—In a broad way, drinking water should be given at least three times a day to horses at rest, and more frequently when at work. Small quantities of water may be given horses at work, even though they are hot and tired. The custom is rather general to give water first, and then after the water some hay, with the grain following later. When horses are put to heavy work their noon feed should consist largely of grain. After being watered the grain is fed and some hay given, that the horse may eat of it between his finishing the grain and the time he is taken out to work.

Many horses show impatience when taken to the stable at noon and are given hay before the grain. For the evening meal the grain should come first, and then, after a brief interval, the hay portion of the ration. A drink of water after feeding is both humane and desirable.

**Regularity in Feeding and Watering.**—Whatever system of feeding and watering is followed, it should



Showing Them Off

be strictly adhered to during the season. Habit is part of the ration. To be given water one day before meals and the following day after meals, is as unsatisfying to the horse as it would be to man. If accustomed to grain before the hay at noon, there will be dissatisfaction if this procedure is reversed the following day. Drink and food should be given at about the same time each day.

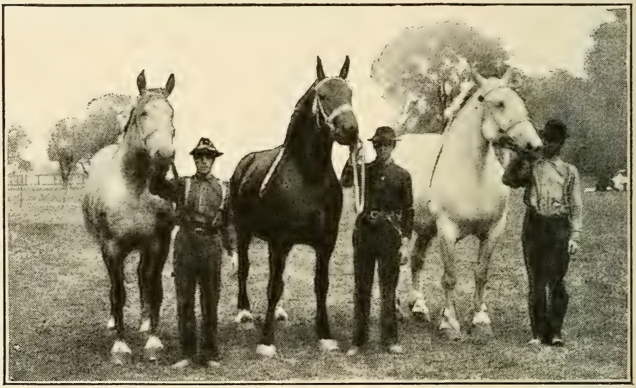
Not only does the animal know when to expect its grain and hay, but the animal system adjusts itself accordingly, and discomfort results if this order is not adhered to. This does not mean that a set scheme should be followed throughout the year, but rather followed during certain periods of the year when special work is performed. During the winter season when farm horses are not called to do strenuous or regular work, a different plan may be followed than that employed in the summer season, when every minute counts. But, winter or summer, a reasonable regularity should be required.

**Roughage Feeds for Horses.**—Timothy hay, oats and corn have become standard articles in horse rations, but many other grasses and legumes are equally available and equally satisfactory. In the middle and northern states the red and alsike varieties of clover, alfalfa and timothy are all good and may be fed in varying amounts. On some farms red clover hay is often the sole food of the work horse during the winter season. It is a balanced food in itself, but somewhat too bulky to be used exclusively when these same horses are put to heavy farm work.

On other farms corn stover, with a few ears of corn, make up the winter ration. Neither of these rations is to be considered ideal, but each would be improved if the two were mixed together. They would give variety, a factor never to be ignored, and the ration would be improved both as to bulk and proportion of digestible nutrients.

In the southern states, Bermuda, herd's grass,

cowpea hay, corn stover, the cereal hays with or without vetch, and other legumes and grasses, admit of considerable choice and variety. Although crimson clover is frequently fed to horses it is not a desirable roughage because of the fuzzy condition of the clover head. Frequently this fuzz curls up into balls, lodges in the intestinal organs, and causes digestive disorders and sometimes death.



EXERCISE NECESSARY EVEN ON FARMS

When not worked farm horses require exercise. If at pasture this is unnecessary, but during winter, or if pastures or paddocks are not available, they should be driven or led about.

In the western states many of the cereal hays, brome grass, alfalfa, prairie hay, corn stover, timothy and the clovers are available. These allow a wide range of roughage materials for horses. In every section millet grows well and is frequently fed. If cut and cured just as the first blossoms appear, a hay scarcely inferior to timothy is made. Overripe millet should not be fed to horses.

Corn stover is a better feed than is generally supposed, but it must be bright, clean and well cured. If allowed to stand in the field for months, the tops and leaves being exposed to the weather, it becomes unfit for fodder. On the other hand, if stored in the barn when damp, it is quite certain to mold, and if fed in this condition will bring on trouble—digestive and nervous disorders. Corn stover is not a well-balanced food. It carries little protein and much of the carbohydrates. With it should go some oats, or oats and corn, or corn and bran, or corn and bran and one of the oil meals.

The truth of the matter is, it does not matter very much what kind of roughage is fed to horses, providing the roughage is well cured, free from dust, and wholesome. An important thing is to provide concentrates that will carry the nutrient or nutrients lacking in the roughage but which are abundantly supplied in the concentrates. Thus, if legume hays are fed the concentrates need not be high in protein, and if the roughage is of a carbonaceous nature, like timothy or corn stover, some concentrate like bran or oil meal should be introduced into the ration.

**Grain Feeds for Horses.**—It used to be thought that oats were indispensable for horses. There seems to be some constituent of this grain that gives mettle and energy. For horses of the roadster type and those where quick action is demanded, oats should be, and no doubt will continue to be, a principal part of the ration, but for farm work the value of oats perhaps has been overestimated. Many tests have

been conducted in which various feeding stuffs have been compared, and the oats theory has been overthrown. It is not so much the kind of concentrate, but rather that the grain portion shall contain the digestible nutrients in the best balance and that they be of an easily digestible nature.

Indian corn shares with oats popularity as a horse food. Corn is a very concentrated food, is heating, but deficient in muscle-forming elements. If fed in combination with timothy or corn stover, too little protein will be provided. Concentrates of a nitrogenous nature, therefore, should be admitted to the ration. Oats then may be used, or bran, or the oil meals, indeed practically any commercial concentrated feed. Bran and oil meal are laxative, and are particularly good when succulence otherwise is not to be had. These may be given in small quantities daily, or fed in larger quantities two or three times a week. Both are extremely valuable articles for horses and may be fed either dry or in mashes. When fed as mash once a week, night is the best time, preferably before a day of rest.

Barley is a principal grain food for horses in many parts of the world. In some of the great breeding stables barley and oats are ground together in proportions varying with the season and fed to stallions and mares. Cottonseed is similar in its chemical composition to linseed meal, but is more highly concentrated and contains more protein. It should be fed with caution, one or two pounds a day, and never to exceed three or four pounds. This concentrate is coming more and more into favor, but some

horses seem never to learn to like it. It is more often used in rations for mules than for horses.

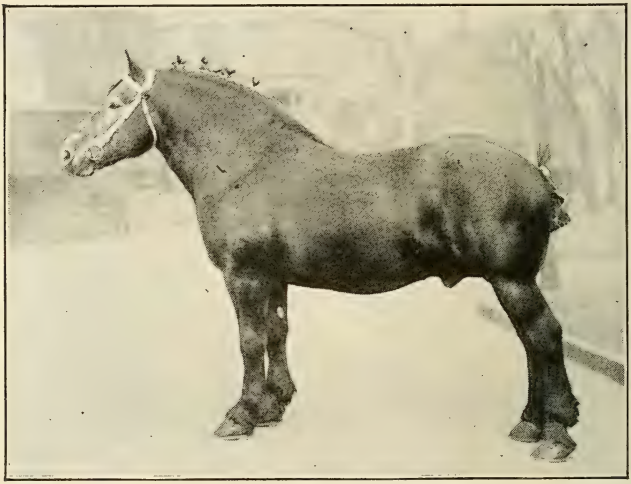
The carrot is the root crop *par excellence* for the horse. It serves to cool the system and assists in the digestion of other food. Only a few roots should be fed at a time and two or three times weekly. Salt is wholesome and beneficial for horses, and attention should be given to this matter. An occasional feeding of salt is not desirable. Salt should be in rock form and placed where the horses can get it at all times when they want it.

**Selecting the Ration.**—In making up a feeding ration for a horse the first point is to find out how much the horse will eat, the next is to regulate the ration according to the demand to be made upon the animal, whether the work is heavy or light, regular or irregular, then consider the feeding stuffs that are available, and finally the season and the weather. The harder the work and the colder the weather, the greater the proportion of carbohydrates required in the food. Be particular, however, to get enough protein, even though it necessitates the purchase of some concentrate, that the horse may get enough to meet the needs of the body machine and to secure the fullest digestion of the other substances.

**Feeding the Stallion.**—A growing three-year-old stallion should do well on the following grain feed: In the morning five quarts of oats and four fair-sized carrots; noon, eight to 10 quarts of mixed feed consisting of two-thirds bran and one-third oats, and a small quantity of hay, if chopped, then mixed with the grain, and dampened with water; at night,

the same mixture as at noon. After the horse has finished this grain ration let him have some timothy and clover hay in addition; no more than what he will eat up clean should be given.

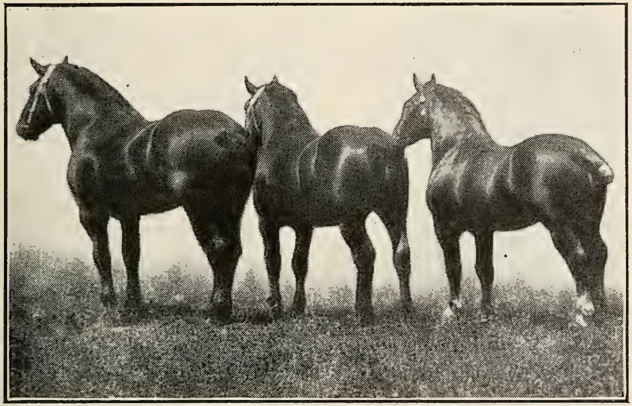
What has been said in reference to roughage and grain materials will apply as well to the feeding of the stallion as to work horses. The stallion should



Stallion for Farm Use

not be overfed but kept in good flesh and in trim condition. Exercise is necessary. During the service period he should have a large box stall wherein he will have freedom to move around, and should be exercised out in the open air a half hour each day. Light work in harness or in the field is not objectionable. This will keep the stallion quiet, make him docile and contribute to vigor and health.

**Fattening Horses for Market.**—The number of horses sold annually is large in the aggregate. The animals are collected from all over the country—one from this farm, one from that, from this place and that. At last all are brought together, whence they are sent to the larger markets in great numbers. Every farmer who has sold a horse knows



HORSES SELL BEST WHEN FAT

When horses are to be sold they should be fat and sleek. The cost of labor and feed will be many times returned.

that each brings a better price if fat than if poor. A fattening ration, therefore, will be profitable for a considerable period before the time set for the sale. Horses will gain from three to five pounds daily for two or three months if properly fed.

A common fattening ration consists of barley, sugar beets, corn meal and bran. The sugar beets are mixed with barley, 25 pounds of beets to a bushel of barley. This mixture is boiled until soft.

To every three pounds of this mixture two pounds of corn meal and three pounds of bran are added and fed warm, mixed with an equal bulk of clean-cut hay. In addition to this, a pint of linseed oil meal is fed. As much salt and water as the fattening animal relishes are given. If roots are not available, then a few pounds of silage will do. In place of barley, oats may be substituted, but corn should compose a large part of the ration. Give freely of the grain mixture. While not stinting in roughage materials, these should be held down to the minimum. A horse will fatten most rapidly on the grain.

**Feeding Mules.**—There is a prevailing notion that mules eat less than horses. Riley, after a long experience with thousands of army mules, maintains that "a mule requires just as much as a horse of similar dimensions." In fact, at hard work, Riley says "that the mule will eat more than the horse will or can." In general, an animal that eats little is a poor animal, regardless of its class or kind. The mule will manage to get along on poor feed given at irregular intervals, but this neglect is manifest in its condition and efficiency. What has been said about feeding work horses applies to mules.

**Good Rations Commonly Used.**—The following rations are in common use at various times and in various sections of the country:

1. Timothy hay, 12 pounds; corn meal, 11 pounds; malt sprouts, 5 pounds.
2. Red clover hay, 8 pounds; oat straw, 6 pounds; corn meal, 12 pounds; wheat middlings, 6 pounds.

3. Alsike clover, 8 pounds; corn stover, 6 pounds; corn meal, 10 pounds; rye bran, 6 pounds; linseed oil meal, 2 pounds.
4. Timothy hay, 12 pounds; corn, 8 pounds; oats, 8 pounds.
5. Hay, 10 pounds; corn, 8 pounds; bran, 2 pounds; linseed oil meal, 2 pounds.
6. Corn stover or timothy hay, 12 pounds; oats or bran, 7 pounds; corn, 7 pounds.
7. Timothy hay, 8 pounds; corn meal, 6 pounds; wheat bran, 6 pounds; oil meal, 1.5 pounds.
8. Timothy hay, 10 pounds; gluten meal, 6 pounds; corn, 6 pounds; bran, 2 pounds.
9. Oat hay, 12 pounds; corn, 8 pounds; bran, 5 pounds.
10. Alfalfa hay, 16 pounds; bran and shorts, 13 pounds.
11. Hay, 6 pounds; brewers' grains, 8 pounds; oats, 8 pounds; corn, 4 pounds; wheat bran, 2 pounds.
12. Hay, 15 pounds; corn, 10 pounds; oats, 13 pounds, wheat bran, 6 pounds.

These last two are for very heavy horses doing very severe work.

In the far West a common ration is alfalfa hay 10 pounds and barley 12 pounds. This ration has been modified elsewhere by using alfalfa hay 10 pounds and corn 10 pounds, and increased or decreased as the work is light, moderate or severe. The army horses in the cavalry are given 14 pounds of hay and 12 pounds of oats.

## CHAPTER XVII

# FEEDING DAIRY CATTLE

**Food Requirements of Dairy Cattle.**—The Wolff-Lehmann standards for feeding the various classes of dairy animals are shown in the table below. They indicate the amount of food required for 1,000 pounds live weight, and are for growing cattle and for cows yielding varying qualities of milk.

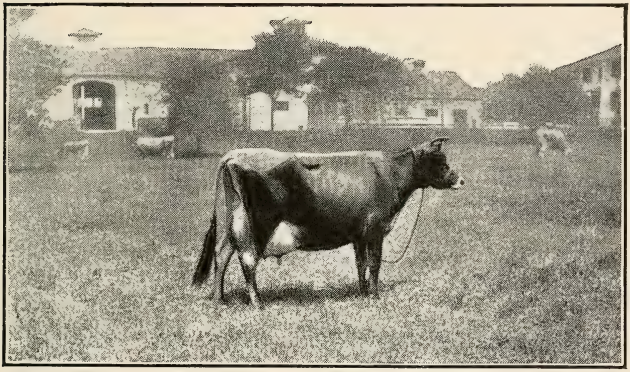
WOLFF-LEHMANN STANDARDS FOR FEEDING DAIRY CATTLE

| Kind of cattle | | Dry matter | Digestible nutrients | | | Nutritive ratio |
|---|---|---|---|---|---|---|
| | | | Protein | Carbo-hydrates | Fat | |
| Growing cattle | | | | | | |
| Age in months | Weight | | | | | |
| 2 to 3 | 150 | 23 | 4.0 | 13.0 | 2.0 | 1:4.5 |
| 3 to 6 | 300 | 24 | 3.0 | 12.8 | 1.0 | 1:5.1 |
| 6 to 12 | 500 | 27 | 2.0 | 12.5 | 0.5 | 1:6.8 |
| 12 to 18 | 700 | 26 | 1.8 | 12.5 | 0.4 | 1:7.5 |
| 18 to 24 | 900 | 26 | 1.5 | 12.0 | 0.3 | 1:8.5 |
| Milking cows; when yielding daily: | | | | | | |
| 11.0 pounds milk | | 25 | 1.6 | 10.0 | 0.3 | 1:6.7 |
| 16.6 pounds milk | | 27 | 2.0 | 11.0 | 0.4 | 1:6.0 |
| 27.5 pounds milk | | 32 | 3.3 | 13.0 | 0.8 | 1:4.5 |

**The Milk-Yielding Function.**—In milk production some breeds have become markedly specialized. The function of giving milk is natural with them, but it has been artificially developed. During the

lapse of the centuries, cows have been saved for the dairy because of their tendency to give much milk or milk of a rich quality. The milk-yielding capacity of the breeds was not achieved in one generation, or in two, nor can it be discarded readily once it has become habitual to the breed, the strain, or the individual.

To the practiced eye there are several indications of milky tendency in dairy cows. These are known



THE MILK-YIELDING FUNCTION EXEMPLIFIED
This Jersey cow comes from a long line of milk producers. It is as natural for her to give milk as it is for her to eat.

to be the wedge-like shape of the body when observed from front, side or rear; the width between the eyes; the fine, narrow forequarters and broad spacious hind quarters; springing ribs, long and wide apart; the refined feminine countenances; the hair, silk-like and smoothly laid on the skin, which, itself, is fine, mellow, and soft to the touch. In addition to these characteristics the stomach should

be prominent, the udder large and neither flabby nor fleshy, with medium large teats, evenly set; and extending forward along the abdomen should be noticed strong, tortuous milk veins, which, carried internally, are admitted by means of large milk wells. These external traits are just opposite to those that mark the best types of the beef breeds.

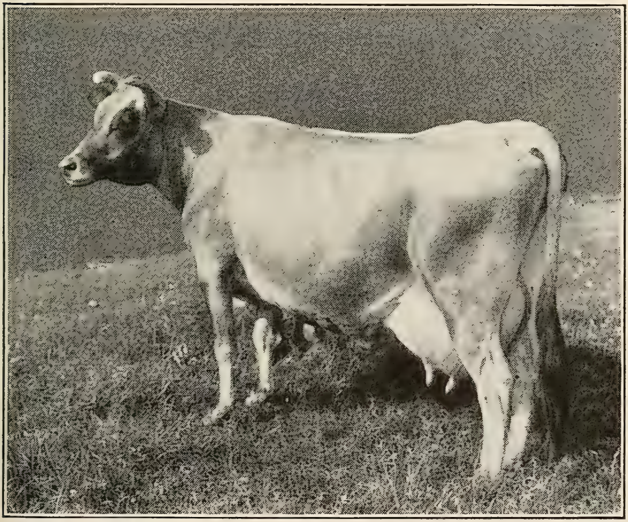
**What Influences Milk Formation?**—The milk-yielding function is hereditary to a certain extent. Certain breeds and certain strains of these breeds possess the ability to yield much milk and to transmit this characteristic to their offspring. Other breeds yield very little milk, and no manner of care or feeding will largely increase the amount or change the character of its quality. Therefore, it can be said with certainty that the influences back of heavy milk formation are the breed and the individuality of the cows of the breed.

Some breeds rank high as milk producers in respect to quantity, others in respect to quality; but in both classes much variation is noted. Among dairy cows there remain large numbers that are useless as milk producers, and their production returns in money are less than the cost of keeping them. In time the milk scales and Babcock test will point these out and they will be discarded from the dairy herds.

**How Often to Milk.**—The custom of milking twice a day has become fixed, and no marked advantage is secured when the number of milkings is increased. Experience and experiments show that three milkings a day increase the amount of milk

secured less than 7 per cent. Considering the extra labor involved, the extra milk obtained by three milkings will not repay the cost and trouble.

**What Age of Cow Is Best?**—The formation of milk is closely associated with the birth of the offspring. The yield increases for several months after calving, and may abruptly or gradually decrease, as the case may be. As a rule the fat increases slightly as the lactation period advances. The young heifer generally will give increasing amounts of milk with each successive calf until the sixth or seventh year, and remain near that point a few years longer, then the milk flow will gradually diminish.



A CLEAR CASE OF DAIRY TYPE
Bred for the dairy this cow represents the highest ideals in dairy confirmation and milk production.

**What Influences the Quality of Milk?**—So far as the question can be decided, the influences that bear most on the quality of milk are breed, heredity and inherent functional capacity. It used to be thought that the kind of food, the care, and the surroundings influenced the quality of milk. When put to actual test this was proved to be incorrect. The quantity of milk, on the other hand, may be, and commonly is, influenced by the amount and nature of the food, the treatment bestowed, and the attention given to all details of dairy management.

The condition of the mammary gland will have much to do with a heavy milk yield. If its capacity is limited, naturally the results will be apparent. Its efficiency is dependent upon the food digested and assimilated. If the food provides the various nutrients abundantly and in favorable balance to meet the needs of the body and of milk production, the quantity of milk will reach the maximum possibilities of the mammary gland and the quality will be in accordance with the functional nature of this organ. From this it follows that the quality of milk of a given cow is without special variation, but that the quantity will be dependent on food and treatment.

In this connection it may be said that certain foods influence the milk yield. Unappetizing and ill-smelling foods depress milk secretion, although they normally provide the nutrients abundantly. The same foods set before the cows in more appetizing and tempting ways often cause an increased flow, although no more provender is consumed.

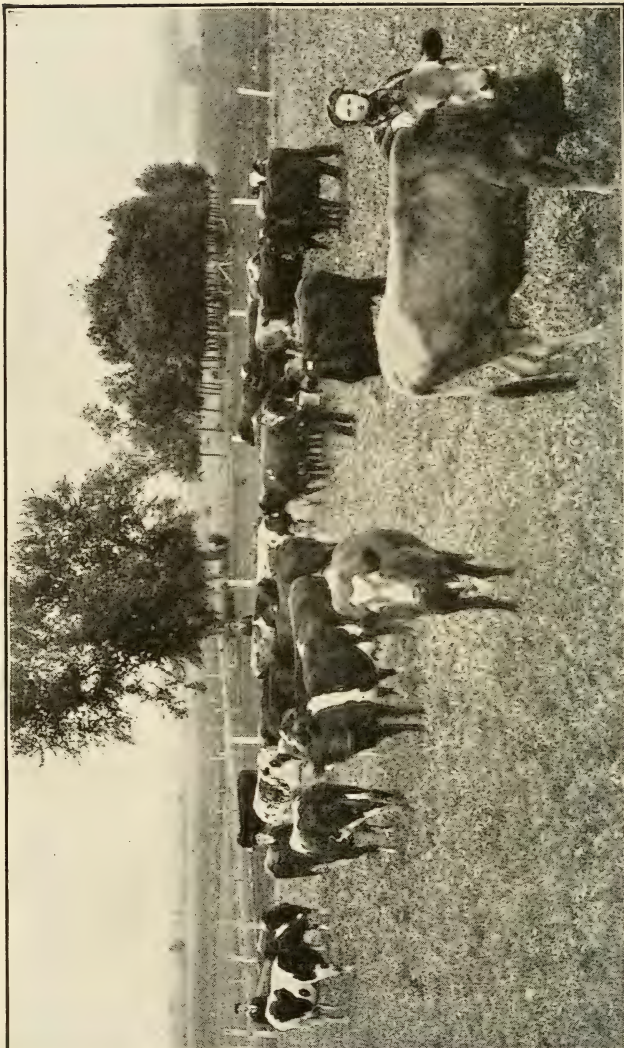
The appetite has a direct connection with the udder.

Cows that are annoyed by flies and other insects, or that are chased about by dogs or other tormentors, will yield milk less in quantity, and, perhaps, poorer in quality, than if they are placed under more comfortable and agreeable conditions. Dairymen are more and more realizing the importance of these facts in practice, and are now giving much attention to the simple details of cow comfort. A little care at this point assists each cow of a herd in giving more milk.

**Pastures Are Ideal Basic Rations.**—In early spring, cows are usually put out on the pastures as early as there is food enough to support them. New grass has generally a very laxative effect on the cows, and if it alone is relied on, it often has a very bad effect. This can be avoided by feeding only partially on grass, completing the ration through the use of both hay and concentrates. In a short time cows become accustomed to grass, on which they may then be left to subsist entirely.

Pasture grass is one of our best foods. It is succulent, fresh and appetizing, and possesses a high nutritive value. The splendid results obtained by having cows at pasture is not solely because the food is unusually well utilized over winter rations, but because it is rich in nutriment. It ranks with the cereals, and everyone knows how effective such feeds are in milk production.

No doubt more protein is consumed than cows require when feeding on pasture, but this cannot be avoided unless the daily grazing period is limited



DAIRY COWS THOROUGHLY CONTENTED IN THE PASTURE FIELD

and some substitute of a carbohydrate nature like straw, timothy, or stover is provided. The objection lies in the refusal of the animals to eat when such are put before them. Once the taste of grass is obtained, cows reject other foods, often including grain concentrates.

When cows in milk are on pasture their treatment is very simple, and quite in contrast to the diligent necessities of the stable during winter. Labor is largely dispensed with, except what is required for milking. Cows that are heavy in calf are nowhere so well treated as when on pasture. They gather their own feed, and even on scanty pasture manage to add flesh and to get in good shape for the fall and winter season of milk giving.

**Feeding Grain on Pasture.**—Many things enter into dealing with the problem as to whether grain shall be fed on grass or not. Cows do give more milk if given grain on pasture, but the cost of producing the milk will thereby be increased and the practice may not be economical. Certainly the cows that give but little milk should not be grained when on good pasture. The very heavy milkers may be given grain, anywhere from two to eight pounds, depending on the yield and the nature and condition of the pasture. One pound of grain to every 10 pounds of milk may be given to the lighter producers, and this may be increased to one of grain to six of milk when cows are yielding from 40 to 50 pounds daily.

The kind of grain will depend on what is available. Corn is satisfactory if but two or three pounds are

given, but in case more is fed, gluten, cottonseed meal or bran should be used in a mixture with corn. Silage is a valuable summer feed and frequently is fed in summer. It is fed in the stable after milking and before the cows are turned out to pasture. One feed a day will be sufficient.

**When Pastures Are Short and Parched.**—During the hot days of late summer the pastures often become parched, dry and scanty. At this time great

MATRONS OF THE DAIRY HERD

care is needed in managing the dairy herd. Unless supplementary food to the pastures is fed the cows are sure to drop off in their milk flow, and once down it is a difficult task to get them back to the point at which they were, and then only after feeding liberally with grain.

The short-pasture problem may be overcome by providing soiling crops like green corn, millet, alfalfa, and corn silage. If a patch of corn be

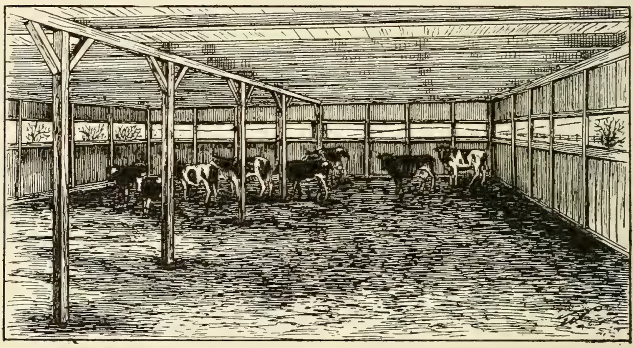
planted on warm land as early in the spring as the weather will permit and planted thickly, by July a great abundance of green forage will be available for green feed. This may be fed in the field in racks, or on the grass, or in the stable mangers. A very large amount of succulent food can be provided in this way at no great expense.

The barnyard millets make excellent green forage. They are usually ready by late July or early August. If alfalfa is grown, a good soiling crop is at hand when needed. Corn silage is coming more and more to be depended upon for such critical periods during the summer season and early fall. Where many cows are kept the silo is almost indispensable.

**Let the Feeding Standards Serve as Guides.**—In the production of milk in winter the outlay necessary for food is much greater than in summer. Not only is much home-grown roughage consumed by cows, but large quantities of grain also. In sections where much corn and alfalfa are grown the feeding of dairy cows is simple; but in the more important eastern dairy sections, where corn, if grown at all, is grown largely for silage, and little if any alfalfa or clover is raised, the problem of feeding cows in winter economically calls for great skill, close study and correct use of the feed.

The most accurate means of determining the ration that any class of cows needs is by calculation based upon the feeding standards. There is more to the balanced ration than is usually credited. If an insufficiency of protein is contained in a given ration, the cow, if she is possessed of a milk-yielding

tendency, will be forced to rob her own body to obtain it. Hence, she will lose in flesh and her vitality will be lowered. On the other hand, if provided with all the protein she requires and at the same time if she is fed more carbohydrates and oils than are needed, she will lay on fat, and sooner or later will yield less milk. If fat is deposited in the mammary glands, milk secretion is certain to be dis-



An Inexpensive Covered Barnyard

The covered barnyard is valuable for preserving manure, and it affords shelter and protection during the winter season. The idea is fast becoming popular on dairy farms.

turbed and a maximum production of milk, for that lactation period, at least, impossible to be obtained.

**Producing Milk Economically.**—In a general way the production of milk economically will be dependent upon high-producing cows and cheap home-grown feeds. On most dairy farms the food raised is of a roughage nature, but just as much of this roughage material as the cows will eat up clean at all times should be put before them. If the legume

hays are grown, the demand for concentrates containing protein will be much lessened, and consequently the expense bills for grain will be much smaller than otherwise they would be. But even with an abundance of the legumes and silage some grain will be called for, and particularly in the case of heavy-yielding cows. Cows with 30 to 50 pounds of milk to their daily credit will not usually be able to manufacture these quantities from farm roughages, even though legumes and silage are included. The bulk is too considerable and the stomach capacity of the cow is unequal to the demand.

This difficulty is met by the use of concentrates which contain only small amounts of fiber and other indigestible substances. Some practical dairymen introduce the grain concentrates freely into the rations, basing the quantity on the amount of milk produced. To cows yielding 20 or more pounds of milk a day one pound of grain is added to the daily ration for each three pounds of milk or for each pound of butter fat produced a week. If much legume roughage is fed, these amounts may be lessened to one pound of grain to every four or five pounds of milk or butter fat. Cows that give milk low in butter fat will need less grain in proportion to the milk yield, and those high in butter fat will need more. It is a delicate problem, each cow requiring individual attention.

**Protein Requirements.**—Some authorities are of the opinion that the Wolff standards for dairy cows in milk call for more protein than is necessary. In the Kellner standards from a quarter to a half pound

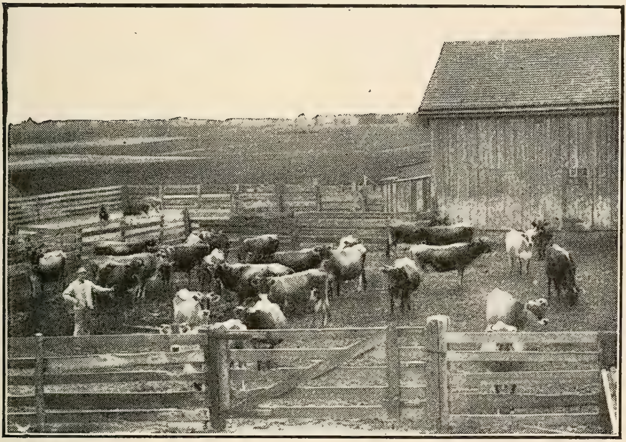
less of digestible protein is recommended, and many American investigators hold to the same view. The suggested change in this respect is of no great consequence, even though the maximum amount of protein is generously supplied. If legumes and pastures enter into the rations, an oversupply of digestible protein is easily possible, but it should be remembered that when so nourished the cows give forth their best production. If protein has a stimulating effect on the mammary glands, as many hold, a generous supply is to be preferred to even a slight deficiency.

## FEEDING DAIRY COWS IN WINTER

**Nature of the Food.**—The kind of food for feeding cows in milk will, of course, be much governed by the production in any given locality. The aim will be to feed approximately a balanced ration. On this point divergence of opinion is not great. Where fertility is in equilibrium the aim of the dairyman should be to grow, as far as may be practicable, the food needed on his own farm. He can, of course, grow his own carbohydrates and fat, and more and more the legumes will be introduced into the cropping system on dairy farms. In this way it will be possible to obtain much of the protein at home. The concentrates that will be used will be purchased largely because of their strength in protein, and will be bought as balancing materials and not as basic fundamentals of the ration.

**Foods That All May Grow.**—A few foods may be looked upon as standard in feeding dairy cows.

Nearly every dairyman can grow these, regardless of his location, and because they are standard foods he ought to try to grow them. These include, as roughage, plants of the clover family, alfalfa, corn silage, soy beans, cowpeas, corn, peas and oats. On every dairy farm there should be a permanent pasture, and this should be intelligently handled, that it



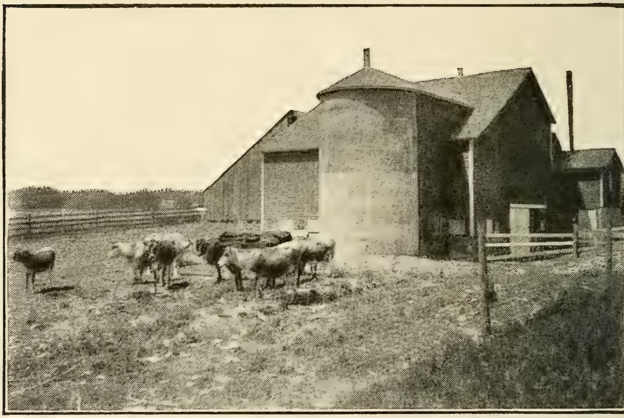
TURNED OUT FOR EXERCISE

Dairy cows will be most healthy when given the run of a pasture during summer and fresh air and exercise during pleasant weather in winter.

may improve steadily. If the pasture land is limited, then some soiling crops should be introduced. These include rye, peas and oats, alfalfa, clover, cowpeas, soy beans, green corn, millet and other crops of local adaptation.

A liberal supply of these feeds is indispensable for milk or butter. On too many farms there is frequently a shortage of hay, silage, or dry prov-

ender. When these are grown insufficiently, either the cows are denied full rations or else purchased feed must be resorted to. Ordinarily the high prices of these absorb the greater part of the profits of the dairy business. On farms where the normal supply of roughage is not equal to the requirement of the stock, it would be wiser, safer and better to dispose of the least productive cows, be-



SILAGE ONE OF OUR BEST DAIRY FEEDS

When feed is high, silage is practically indispensable in dairying. For winter feeding it is a fair substitute for summer pasture, for corn ensiled is more appetizing than if fed dry and in the rough.

stowing on the remaining ones more care and feeding them more generously on the roughage material at hand.

Next to the legumes no food is grown that provides so large a proportion of desirable nutrients as corn preserved in the silo. The nutrients in silage are very appetizing for winter feeding. Moreover,

the succulence of silage is beneficial; it aids digestion, and, of course, favors milk production. It is undoubtedly true that wherever dairy cows are kept, the silo is indispensable, both for economical feeding and for the production of milk at a reasonable profit.

**Available Grain Feeds.**—The list of concentrates for dairy cows is practically unlimited. The cost, however, must be considered. It is not enough that a concentrate be labeled a food for dairy cows; it must possess a relatively large amount of protein and a small amount of fiber. The less of fat and carbohydrates in proportion to the protein, the better, provided the supply of home-grown roughage feeds is sufficient to meet the demand. In the past too little attention has been paid to the chemical composition of the concentrates. The custom has too long prevailed of buying these by name, whereas the only thing that counts is merit. The only sensible rule to follow is to study the composition of each feeding stuff, and ascertain which kind or brand will give the largest quantity of digestive nutrients and the largest quantity of digestible protein. This information will be of incalculable value in buying feeds and will be a means of saving money.

Among the most useful and best liked concentrates are cottonseed meal, linseed oil meal, gluten meal, gluten feed, bran, brewers' grain and malt sprouts. The several by-products of starch and cereal food factories are extensively advertised, but they usually sell for more than they are worth.

Cereal grains are often fed dairy cows, corn more so than other cereals. On farms where alfalfa and clover form the bulk ration, corn may be fed if its market value is on a level with better-class meals and other grains. If corn silage be fed in connection with timothy or mixed grasses and corn stover, corn will not be a desirable food. There will be wanted in this instance and in others like it, concentrates like oil meal, wheat bran, gluten, distillers' grains or other concentrates of which protein is the predominating factor.

**Grain and Quality of Butter.**—The character of the food frequently influences the quality of the butter. The white, hard, tasteless character of winter butter results from the food given. Fresh pasture, bright legume hays, corn silage and soiling crops give color to the milk and to butter. Gluten or corn produces a soft butter. Wheat bran makes a harder butter than either. If much of gluten is introduced into a ration, the butter will be soft, but its hardness may be improved by the use of cottonseed meal, a feed that makes a very hard butter. By mixing the two, a better grade of butter will be obtained than if either is used alone. A pound or two of cottonseed meal when the cows are on pasture helps to counteract the objectionable softness of butter during the pasture season.

## FEEDING YOUNG DAIRY STOCK

**During the First Winter.**—Calves dropped in the spring and early summer will be growing nicely by the time they are put up in their winter quarters. A

difference of opinion still obtains as to whether it is better to raise young calves intended for the dairy on skim milk or on whole milk during the first few months of their lives. The skim-milk ration is, of course, the less expensive and many of the best dairymen believe it develops the best calves. They

PICKED OUT FOR THE DAIRY

These young calves have been fed skim milk in which has been placed a small quantity of oil meal. Ground oats is to be added to the ration.

claim that the calves so fed are stronger and possess larger capacity for digesting rough feed subsequently. Whichever claim is nearest to being correct, it is a fact that most dairy calves are now raised on skim milk or milk substitutes.

In either method, the calves should be early accustomed to eating grain, grass, and later in the fall,

some kind of legume hay. They will then go into winter sturdy individuals able to render a good account of the feed given them. The spring-born calves need no longer be given milk, though they may have it if it is plentiful. The fall calves, however, should not have their supply cut off if this can be avoided. Let both classes have all the hay they will eat up clean. It is poor economy to limit their roughage supply. You want big stomachs, large frames, and vigorous individuals. There is nothing so good as a plentiful supply of good legume hay to get these results.

**Satisfactory Grain Mixture.**—Many young calves are wintered without grain, but such a method is not to be recommended. Some grain is necessary if steady growth is sought. A mixture of coarse corn meal three parts, wheat bran one part, and linseed oil meal one part will give very satisfactory returns. The grain is to be given in two feeds, morning and evening. Hay may be put in the mangers both morning and night, and at noon also if convenient.

This plan of feeding may be followed throughout the winter, the amount of grain being gradually increased as the calves grow. In the spring the same precaution in accustoming the animals to pasture should be observed as for the milk cows. When safely settled on grass the grain ration should be gradually decreased until a small amount is fed, or none at all. The governing factors will be the kind and character of the pasture.

**During the Second Winter.**—The calves will now be far along, and some of them will have been bred. The roughage food will be of a character similar to what it was the first winter. The same liberality in feeding is to be followed and the grain supply is to be more than before. Ground oats, wheat bran and linseed oil meal will now be more largely fed, because these are all good as building materials and stand high as carriers of mineral substances.

If corn is expensive or limited in quantity, it can be dropped from the grain mixture altogether. Silage is excellent, so are roots, and if either is available, a limited amount, say 10 to 15 pounds, should be given daily. Fed in this manner dairy calves will enter their work stalls as well-equipped milk producers, possessed of strong constitutions, rugged physiques and vitality equal to long service and much profit to their owners.

## STABLE MANAGEMENT

**Salt and Water.**—Cows should have salt, either added to their rations or furnished in lump form where it can be taken at will. In the latter way they may take too much. If added to the feed, from a half ounce to an ounce and a half should be furnished daily to each cow. Cows do not need to have water kept before them continuously, summer or winter. They need a liberal supply at all seasons, however; and ice water is not good, since they often will drink really less than they need. If comfortably stabled in the winter, natural water, even if cold, will be satisfactory.

**The Practice of Dishorning** is to be encouraged, as cows seem to give more milk and are more safely handled.

**The Tuberculin Test,** consistently employed, will eradicate tuberculosis from a herd. It has no effect on the yield of milk and butter fat.

WATER AVAILABLE ALL THE TIME

Dairy cows require an abundance of water, and they want it fresh and clean. In the winter they should not be required to drink ice water.

**The Herd Bull** should not be permitted to run in the pastures with the cows, as is the custom on many farms. Much exercise is advisable and may be provided for by run lots, moderate work in special instances, and in the use of chain and ring attached to cable. The bull may be stabled in stall or box stall in the same building with the cows, or kept in a small outside building where shelter is available.

In a small run connected with the building freedom and exercise may be had. Food, similar in character and amount to that given the cows, usually is fed. Nutritious roughage and succulent food should be supplied generously, and may form the bulk of the ration. During the period of greatest service, rich food of a protein character should be fed liberally.

**The Order of Supplying the Food** will vary as circumstances arise. Certain foods, like cabbage, silage and turnips, will be less likely to taint the milk if fed after milking. Grain may be given just before or some time previous to milking. In the case of hay less trouble will follow from dust and odors if fed after milking. The following order is followed on many up-to-date dairy farms: Milking, first; then the grain feeding; then silage or roots; stable cleaning while the cows are watering; following this work come hay feeding and grooming. If the weather is pleasant, the cows are turned out for exercise and morning air. Towards evening the cows are watered, fed grain, milked, fed the silage or roots, and then are given their final supply of hay.

## SOME SAMPLE RATIONS

**For Dairy Calves.**

Provide a grain mixture consisting of ground oats and corn meal, each three parts, and oil meal and bran, each one part.

In summer: Keep on pasture and give about 2 pounds of the mixture to six-month calves, 3 pounds to yearlings and 4 pounds to those 18 months old if pasture is short.

In winter: Continue the grain mixture, giving the yearlings 4 pounds and those 18 months old 6 pounds. Let them have all the alfalfa, clover or cowpea hay they will eat up clean.

**Dry Cows in Summer:**

1. Give run of pasture.
2. If pasture is very short, as calving time approaches feed from 1 to 3 pounds of bran daily.

**Dry Cows in Winter:**

1. Clover, alfalfa or mixed hay, 15 pounds; corn silage, 20 pounds.
2. All hay and stover cows will eat. As parturition approaches use up to 3 or 4 pounds of wheat bran, beginning at 1 pound daily at first.

**For Cows Yielding From 16 to 25 Pounds of Milk Daily:**

1. Corn silage, 40 pounds; clover hay, 15 pounds; ground corn, 3 pounds; cottonseed meal, 1 pound.
2. Cowpea hay, 15 pounds; corn stover, 10 pounds; corn silage, 30 pounds; cottonseed meal, 2 pounds.
3. Alfalfa hay, 18 pounds; corn silage, 35 pounds.
4. Corn stover, 15 pounds; corn meal, 1 pound; linseed meal, 2 pounds; wheat bran, 5 pounds; cottonseed meal, 2 pounds.

5. Sorghum fodder, 50 pounds; hay, 7 pounds; bran, 4 pounds; corn meal, 3 pounds; oil meal, 2 pounds.
6. Corn fodder, 8 pounds; clover and timothy hay, 7 pounds; sheaf oats, 5 pounds; rutabagas, 3 pounds; bran, 2 pounds; oats, 3 pounds; corn meal, 3 pounds; oil cake, 2 pounds.
7. Prairie hay, 20 pounds; corn fodder, 10 pounds; corn meal, 6 pounds; bran, 3 pounds; oil meal, 1.5 pounds.
8. Clover hay, 10 pounds; corn stalks, 20 pounds; corn and cob meal, 10 pounds; bran, 1 pound; roots, 8 pounds.
9. Alfalfa, 35 pounds; bran, 7 pounds; barley, 3.5 pounds.
10. Hay, 10 pounds; silage, 35 pounds; bran, 3 pounds; corn and cob meal, 3 pounds; gluten meal, 2 pounds; cottonseed meal, 2 pounds.

**For Cows Yielding from 25 to 40 Pounds of Milk Daily:**

1. Corn silage, 40 pounds; clover hay, 15 pounds; ground corn, 3 pounds; cottonseed meal, 4 pounds; wheat bran or gluten meal, 3 pounds.
2. Corn silage, 35 pounds; corn stover, 6 pounds; wheat bran, 4 pounds; dried brewers' grain, 4 pounds; cottonseed meal, 2 pounds.
3. Soy bean silage, 35 pounds; alfalfa hay, 8 pounds; corn meal, 6 pounds.
4. Crimson clover hay, 10 pounds; cowpea silage, 35 pounds; dried brewers' grain, 5 pounds; cottonseed meal, 2 to 4 pounds.

A BUNCH THAT TOPPED THE MARKET
They were fed corn and cob meal, gluten meal, oil meal, and chaffed clover hay.

5. Corn silage, 40 pounds; corn stover, 7 pounds; wheat bran, 5 pounds; dried brewers' grain, 5 pounds; cottonseed meal, 2 pounds.
6. Alfalfa hay, 20 pounds; corn meal, 8 pounds; cottonseed meal, 2 pounds.
7. Alfalfa hay or clover hay, 15 pounds; corn silage, 20 pounds; bran, 3 pounds; linseed oil meal, 2 pounds; ground oats, 2.5 pounds; hominy feed, 2.5 pounds; gluten feed, 5 pounds.
8. Clover, alfalfa or cowpea hay, 10 pounds; green cut corn, 40 pounds; hominy feed, 5 pounds; cottonseed meal, 1 pound; distillers' grain, 8 pounds.
9. Corn silage, 35 pounds; clover hay, 9 pounds; corn, 5 pounds; cottonseed meal, 2 pounds; bran, 2 pounds.
10. Mixed hay, 15 pounds; dried beet pulp, 4 pounds; gluten feed, 2 pounds; cottonseed meal, 2 pounds; corn meal, 2 pounds.

## CHAPTER XVIII

## FEEDING BEEF CATTLE

**Food Requirements for Beef.**—The Wolff-Lehmann standards for feeding the various classes of cattle are shown in the table below. They indicate the amount of food required per 1,000 pounds live weight and are for both growing and fattening beef animals.

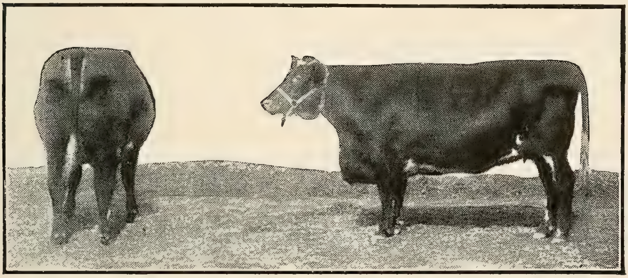
WOLFF-LEHMANN STANDARDS FOR FEEDING BEEF CATTLE

| Kind of cattle | | Dry matter | Digestible nutrients | | | Nutritive ratio |
|---|---|---|---|---|---|---|
| | | | Protein | Carbo-hydrates | Fat | |
| Growing cattle | | | | | | |
| Age in months | Weight | | | | | |
| 2 to 3 | 160 | 23 | 4.2 | 13.0 | 2.0 | 1:4.2 |
| 3 to 6 | 330 | 24 | 3.5 | 12.8 | 1.5 | 1:4.7 |
| 6 to 12 | 550 | 25 | 2.5 | 13.2 | 0.7 | 1:6.0 |
| 12 to 18 | 750 | 24 | 2.0 | 12.5 | 0.5 | 1:6.8 |
| 18 to 24 | 950 | 24 | 1.8 | 12.0 | 0.4 | 1:7.2 |
| Fattening cattle | | | | | | |
| First period | | 30 | 2.5 | 15.0 | 0.5 | 1:6.5 |
| Second period | | 30 | 3.0 | 14.5 | 0.7 | 1:5.4 |
| Third period | | 26 | 2.7 | 15.0 | 0.7 | 1:6.2 |

**Wild Cattle Are Seldom Fat.**—Animals in a wild state are not easily fattened. It has taken many centuries of careful selection and breeding to bring the cattle of the plains or the lowlands or the mountains up to a point at which they will lay on gains rapidly and at a reasonable cost. It has been the work of

the breeder to select out of the whole those individuals that were most disposed to fatten easily and naturally, and use them as foundation stock for an ever-improving race of meat animals.

In time breeds have been developed that represent in a high degree this tendency or disposition to give rapid increase and to fatten readily. With all the care, however, there is a large proportion of the cattle stock that is still inferior for any purpose for which it might be selected.



THE SAME COW, SIDE AND REAR

Here is a typical beef type. Observe how she differs from the typical dairy cows previously shown.

Success in the feed lot will depend on the class and the inheritance of the animals selected. Hence, in fattening cattle, the first task is to select the right kind of animals—those that have been bred to fatten, that possess hidden quality and that are of the conformation which practical experience has shown to be associated with rapid increase and tender, juicy meat.

**Younger Stock Now Being Fattened.**—In the old days cattle were carried along for four or five years

and then fattened. The new idea is to grow beef. Young animals are now brought to maturity and finish at as early an age as possible. If steers can be brought by liberal treatment to marketable weight at 12 or 18 months old, the amount of food consumed will be smaller than if two, three or more years are spent in attaining the same weight. Thus the food that would have been consumed for animal heat and energy during the longer period can be saved.

Of course only a good class of cattle can be chosen if this style of beef making is to be followed. There will be no place in it for scrub animals. Only highly bred individuals possessing good quality, good health, and right type can be used to win in this race of quick finish. But it is obvious that when steers can be brought to market condition at an early age the profit can be greatly increased.

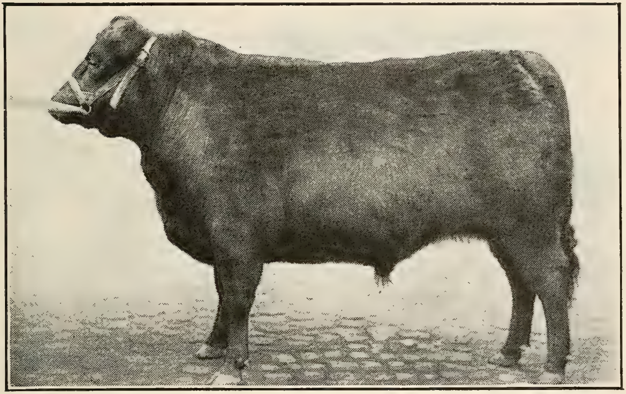
This method of beef raising means more than the selection of animals having a disposition to fatten. It requires more on the part of the feeder, and also better feeds, prepared in appetizing forms and so compounded as to meet the food requirements at every stage of growth.

## GOOD AND BAD BEEF STOCK

**Character of a Good Steer.**—The steer that will fatten readily is low-set, deep, broad and compact, rather than long-legged, gaunt, narrow and loosely put together. The broad, compact form indicates good constitution. Low-set animals are usu-

ally good feeders. The top and the under lines should be nearly parallel. Prominent hips, tail, head and shoulders should be avoided, as smoothness of outline is essential.

Good quality is indicated in a smooth, refined head, fine bones, and thin skin, with a covering of silk-like hair. The skin should be loose and mellow.



A Beef Steer of High Quality

This animal is Black Rock, the grand champion steer of the 1905 International live stock show. He was a good feeder and rendered a splendid account of all the feed he consumed.

Strong constitution is indicated by a wide, deep chest, long and well-sprung ribs, compactness of form and fineness of bone.

**Two Classes of Beef Animals.**—It is obvious that lean feeding animals that have depended on scant pastures require a different ration when put in the feed lot than those in moderate condition. In the thin stock the fibers of the flesh need development

in order that fat may be stored in between and among them. Such animals require a feeding period of three or four weeks, in which a greater quantity of protein will be given than later on.

After this preliminary feeding the proportion of carbohydrates and fats may be increased. A limit as to the amount of fat, however, is to be observed. When more than a couple of pounds of digestible

ROUGH FEEDERS

Poor stock and poor feed, without exception, mean poor farming.

fat are taken into the system, the appetite and the digestion are disturbed. A ration containing from a pound to a pound and a half is to be preferred to one containing two pounds of fat or more.

**Nature of the Ration.**—During the period of growth and approach of fattening the amount of roughage food may be considerable. This will decrease as the fattening period advances, and more of the concentrates will be introduced to meet the changing needs of the fattening ration. For intensive feeding the coarse fodders, like stover and straw, must give way to the legume hays and grain.

Pasture is a splendid food, but high finish is seldom possible with it as the exclusive feed. A short period in the feed lot with corn and oil meal or cottonseed meal is necessary. Pasture feeding is necessary for profitable money returns covering the greater part of the life of the steers. The better the condition when taken from pasture the quicker the steers can be finished, and consequently the greater the profit.

Even at best, finishing cattle is a risky business and needs to be watched with sharp eyes. But heavy feeding is desirable. To stretch out the fattening period is to increase the risk and to lessen the profit unless favored by a rising market. Quick work in the feed lot is usually cheap fattening.

## FROM CALF TO STEER

**Feeding Calves Intended for Beef.**—Two methods of feeding are open for young calves. One is to allow the calf to remain with and take its milk from its mother, the other is to remove the calf, substituting skim milk for the whole milk. The latter plan is extending for the reason that butter fat is important, commercially. The skim milk fed calf, while at a disadvantage, can be profitably developed. Excellent substitutes for the fat in the milk are available in the grains and can be secured at a small cost compared with butter fat.

A calf raised at its mother's side makes rapid growth and at weaning time is in excellent flesh. The skim milk calf is usually not so plump but is

of larger frame than the whole milk fed calf. Whichever method is followed, in either case the calves should be grained in accordance with their needs while on the milk diet. They should be fed grain just as soon as they will take it.

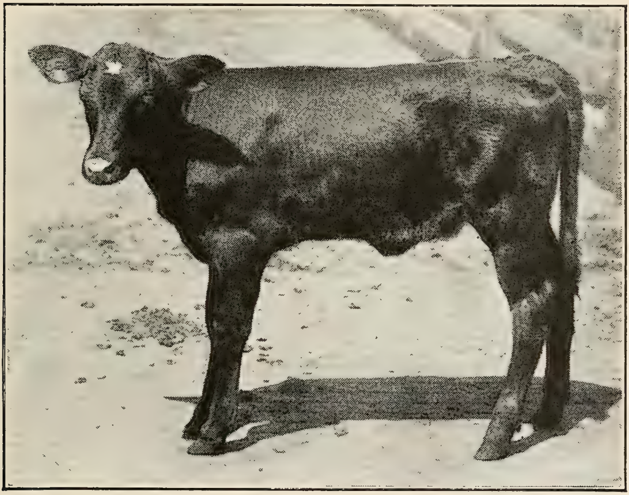
**The Skim Milk Calf** should have oil meal added

SELECTED FOR BABY BEEF

These calves are ready to fatten for baby beef. Well-bred individuals of good form and quality are necessary for success in this kind of feeding.

to its milk diet while the change from whole to skim milk is under way. At first a very small amount, as little as a tablespoonful, may be given. This quantity will be increased when whole milk is no longer given, and still further increased as the calf grows older and larger.

These calves should be on pasture, be fed oil meal and skim milk twice each day, have clean water available for drink, and have placed before them a mixture of other grains like cracked corn, wheat bran and ground oats. If encouraged they will at first nibble this; in time they will eat it greedily.



Good Veal

Veal calves sell at good prices, but they withdraw vast numbers from the supply of available cattle stock.

But so fed they will show steady growth and carry good flesh.

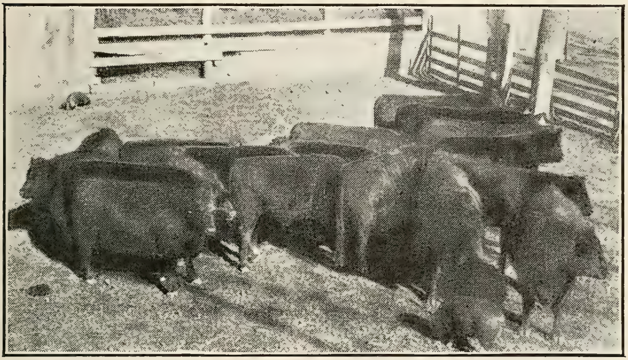
**Calves on Whole Milk** will show fine flesh at weaning time. If allowed to run with their dams on good pasture, but little additional food than the milk will be necessary. It is an excellent practice, however, to encourage whole milk calves to eat grain

as soon as they will take to it. Ground oats, bran and corn comprise a mixture that always fetches good results. Whole milk calves when separated from their mothers should have the run of a good pasture, and the grain mixture should be fed in increased quantities right up to weaning time. Ordinarily no mishaps will occur, and after being weaned the calves will hold their flesh and keep on gaining steadily.

**Making Veal.**—While much veal is made from feeding skim milk and milk substitute grains, undoubtedly the highest quality of veal is obtained by exclusive whole milk feeding. The calf is either left with its dam or is early taught to drink milk from the pail. If the latter method is followed, it may be given all the milk it will consume. If for any reason additional food is given, let it be of an easily digestible nature, and reasonably high in protein. In other words, the nearer it resembles milk the better.

Veal calves should be comfortably housed and restricted in their freedom of running about. Much exercise calls for much food, hence makes more difficult the work of fitting for the market. An increase of 1½ to 2¼ pounds in live weight should be expected daily. Ordinarily a gain of one pound will be made from each gallon of milk consumed. Strong, sturdy calves will take from a gallon to a gallon and a half of milk soon after birth. This amount should be increased steadily until a couple of gallons or more are daily consumed.

**Feed During the First Winter.**—The aim of feeding during the first winter should be to supply in liberal quantities digestible protein and mineral matter. Comfortable quarters must be provided for protection against inclement weather. Shelter is of more importance during the first winter than at any subsequent age. Cattle men are giving less attention in these days to inclosed stables and barns than



Baby Beef

These are ready for market and will be sold for baby beef. Note the high quality and finish.

formerly. Open sheds, facing the sun and protected from rains and storms, will satisfy all the demands for comfort and shelter that full-grown steers require.

The kind of food set before these calves will depend somewhat upon the age at which they are to be marketed. If they are to be finished during late spring or early summer on grass, they should have a very liberal supply of food, with steadily increasing

amounts of grain. The protein supply will be kept up because of the rapid growth which calls for this nutrient.

Towards the close of winter the protein requirements decrease markedly in proportion to the live weight. Hence, the albuminoid ratio of the ration of growing beeves may be steadily widened to the limiting value, which is in the neighborhood of one part protein to eight to ten of the carbohydrate equivalent. Let the food be ample, so as to secure growth, but not of such a character as to encourage too rapid fattening.

The best results will be secured during the calves' first winter if alfalfa, clover, cowpea or soy bean hay is made the basis of the ration. Let the calves have about all they will eat. If corn silage is available, from 10 to 15 pounds may be fed daily. If there is a tendency to scour under this feeding, limit the legume hay and silage and introduce a few pounds of timothy, prairie hay or corn stover. Calves fed in this manner should consume from 10 to 13 pounds of roughage daily.

As for grain, nothing is better than corn, and particularly so if a legume hay is fed. From two to four pounds may be fed each day. In case grass hays, corn stover and corn silage must be used for roughage, some protein concentrate will be necessary in addition to corn. For this purpose linseed oil meal, cottonseed meal or soy bean meal may be used. A pound or two of either, mixed with the corn, will meet the requirements. Oats are good, but the price usually is against them.

**Finishing Beeves Under 18 Months.**—When calves are to be finished as baby beeves, their ration will take on more and more grain concentrates as winter passes. Corn should be fed in liberal amounts, from one-half to three-quarters of the grain portion consisting of it. In case legumes are

PRIME STEERS

On many farms it is more profitable to carry the steers to greater age than to market as baby beef. This is a bunch of prime steers.

largely fed, the grain portion may consist largely of corn, with enough oil meal or bran to give a safe supply of protein. In the absence of alfalfa, clover or other legume hay, one of the oil meals should be used to the extent of 20 per cent of the grain.

The ration should be steadily increased to meet the steady growth and weight taken on during the

several weeks of feeding. By spring these calves, now yearlings, should weigh from 800 to 1,000 pounds and be in such good flesh that they may be marketed in a very short time after being put on a finishing ration. If finished at once, the roughage will be decreased and concentrates proportionally

HERD OF ANGUS IN MIDDLE WEST

Beef raising has long been popular in the middle west, where corn, alfalfa, clover and other beef-growing crops flourish so abundantly.

increased, but consisting of the same or similar feeding stuffs as previously fed.

**Baby Beeves Finished on Grass.**—In case pasture is abundant the grain can be fed less heavily during winter and the finishing of the calves ended a few weeks later on grass. Less grain will be required under this plan during the winter. On grass,

however, an ample supply of grain will be called for. The grain ration should contain 15 to 20 per cent of oil meal or cottonseed meal if the calves are pastured on timothy, prairie, Bermuda or blue grass. If the pasture consists of mixed grasses, clover and alfalfa, not more than 10 per cent of the concentrates need to be of a protein nature. Calves fed in this manner should weigh from 1,000 to 1,200 pounds and be ready for market before tormenting insects and hot weather come to annoy them.

## BEEVES FINISHED AT TWO YEARS OF AGE

**Objections Against Baby Beef.**—For animals brought up to marketable stage as baby beef, continuous grain feeding from birth to the end is necessary. Whether this is best is still an unsettled problem, even though many men are able to secure good profits by following the plan. The method has its limitations. While adaptable to the lines of farming operated on certain farms, the practice of carrying cattle along until in the range at two years of age is still the more popular practice. Most likely it meets the conditions of the average farm on which beef cattle are grown.

In the first place the steer is, by nature, a good instrument for converting large amounts of coarse or bulk food into meat. The pig is not able to do this. Compared with the pig, the baby beef steer renders a less satisfactory account of the grain it consumes. For this reason doubtless this pig com-

petitor will limit the extent to which baby beef will be produced.

When calves are fed that they may be ready for market at or around two years of age, their first winter's food should be of such a nature as to secure favorable growth and to keep them steadily on the gain. The manner of feeding will depend on the nature of the roughage foods, as has been discussed heretofore. In the spring these calves will go on grass, and if the pasture is good, grain will ordinarily not be fed. If hot, dry weather cuts short the pasture, light grain feeding will be advisable. The skillful farmer will watch these matters as they arise and meet them in accordance with his best judgment, which will be influenced very largely by the amount, kind, and market value of the grain on hand, and the cost incidental to obtaining a supply of commercial feeds.

During the second winter the steers will be fed on hay, stover, and silage if available, and grain. The steers should be allowed to eat all the roughage food they want. If alfalfa, clover or other legume hay is fed, more corn in the grain mixture may be used. In the absence of a legume hay then protein concentrates will be necessary. From two to five pounds may be fed daily at first. The nature of the hay, the character of the cattle, and the market price of feed, must all be considered in deciding the kind and amount of each.

**Finishing Two-Year-Olds on Grass.**—In feeding out steers that have passed through two winters and are in good flesh pastures are a great help. During

the second winter grain will be fed rather liberally. By May or June such animals ought to be of a marketable finish if turned on good pasture and fed heavily on grain. Corn is sufficient on alfalfa; but, pastured on mixed grasses, at least 10 per cent of the grain should consist of oil meal, cottonseed meal or gluten meal. Steers fed in this way should gain two pounds on the grain mixture.

Cattle on Alfalfa

With corn and alfalfa in abundance there is always profit in cattle raising.

**Summer Feeding on Grass.**—On many farms early spring pasturing is delayed until grass has attained a fine growth, and the sod has become dry enough after the spring rains to prevent injury from tramping. During this period the steers are continued in the feed lot and fed silage, hay and grain in amounts liberal enough to give a fair rate of increase at a reasonable cost. The steers are then put on pasture, the grain increased and a market finish obtained as early in the summer as possible.

Care will need to be exercised in changing from dry feed to grass; otherwise shrinkage will be certain to follow. The steers should be turned on the pasture for a short time at first, gradually lengthening the grazing period day by day. In this manner they will become accustomed to grass and the risk

FAMILIAR SCENE ON THE STOCK FARM

Cattle take their grain from the feed box and the pigs gather up what falls to the ground. Usually no additional food is given the pigs other than what they gather from the waste and the droppings.

of scours will be minimized. An attack of scours will do much harm; often it will cause a loss of a month or more in the steer's growth.

**Fall Feeding on Grass.**—On many farms the older beeves are pastured through the summer, with little or considerable grain, as the case may be, and finished on new corn. The corn is hauled direct from

the cornfield to the pasture and is fed on the stalk. If little or any grain has been given previously, only a small feed at first is hauled out to them. As rapidly as may be done safely the corn may be increased, until in a month or six weeks the steers are on full feed. From now on they may refuse much of the forage. Where this forage is of value, snapped corn should be substituted for half of the ration.

If the pasture is short, at the beginning of winter, shocked corn may be used for roughage. When the pasture is no longer available, protein feeds must be used, and some shelled or ground corn used in connection with them. Under this system of feeding, pigs should be permitted to follow the steers, else much valuable grain will be wasted. Not only will this method admit of steady growth of the pigs, but these animals will practically grow up to marketable finish, thus giving a double chance of profit from the use of the grain.

## FEEDING FULL-GROWN CATTLE

**Older Steers Are Still Marketed.**—In some sections cheap lands are yet the rule and more pasture is available than could be used economically under the tillage system utilized. Under these circumstances older steers are preferred. They are bought of neighboring farmers at all ages and at small cost and turned on pasture where they are forced to shift for themselves. So placed they grow slowly, may or may not keep steadily on a gain, but in time attain size and foundation for fattening.

The initial cost is, of course, inconsiderable, and the outlay for feed is practically nothing. During favorable seasons pastures may be good. Then rapid increase will follow as a certainty. Steers raised in this manner mature slowly, but they will not have cost much. Even if they are three years old or more, the total cost will be at such a low

FEEDING BEEF CATTLE IN THE OPEN

It used to be thought that steers were most profitably fattened when stall fed. It has been found that they do even better if cared for in the open. Many feeders prefer open sheds for feeding during inclement weather.

figure that some profit is bound to result. The finishing period, preliminary to getting ready for slaughtering, may be short or long. It will depend somewhat on the condition of the animals and the state of the market. Given the run of a good pasture, and supplied corn and other concentrates for a short period, a reasonable finish and often highly satisfactory money results are to be expected.

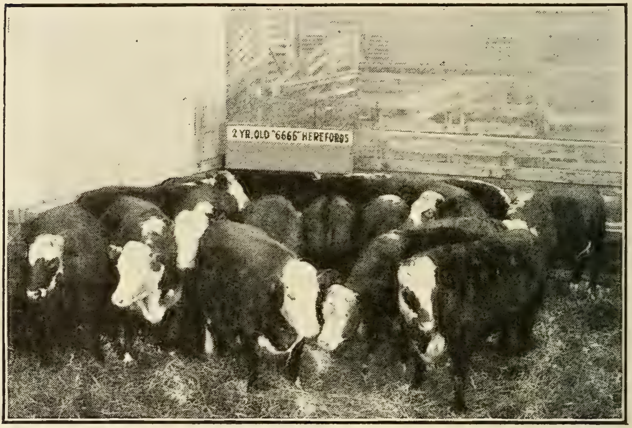
Often steers of this nature are carefully and painstakingly fattened, and when sold bring the highest prices that the market pays.

**Fatten the Heifers Early.**—Heifer calves are very good for baby beef. They naturally take on fat and flesh, and if brought up to a marketable condition by the time they are a year or a year and a half old they will fetch as good prices as steers of the same age. By turning heifers off as baby beeves annoyance from the period of heat is lessened. Otherwise, unless spayed, heifers will fret and disturb the rest of the herd periodically, and not attain best development themselves. It follows that if many such heifers are in a herd there will be continuous excitement and disturbance, which is bad for the entire bunch. It means that the heifers must be separated as they come in heat if the trouble is to be squarely faced; but it is a fact that few cattle men do this. Ridding the herd of these open heifers at an early age as baby beeves seems to be a sensible and wise settlement of an annoying problem.

## PROMINENT FEEDING STUFFS

**Many Kinds of Roughage Foods.**—Local conditions will have much to do in the choice of roughage foods. The various hay crops, corn stover, fodder corn, and silage are all valuable at certain periods of the steer's growth. They will be used in scant or liberal quantities, in accordance with the supply and the general style of farming. Pastures either of a temporary or a permanent nature will go

hand in hand with the forage crops grown on the farm. The aim of the future should be to include the legumes more and more, although the grass hays and the products of the corn plant will always occupy an important place in the food supply for growing and fattening cattle.




Champion Steers

This carload of steers was awarded champion honors at a recent live stock show.

It is not so much what kind of roughage is to be used as it is that there be an abundance. With even inferior roughage it is possible to develop cattle economically if good pastures are available and protein concentrates in reasonable amount are fed. It should be remembered that if there is much corn stover there is also much ear corn. This corn can be fed or exchanged for other concentrates that carry large quantities of protein, to assist in balanc-

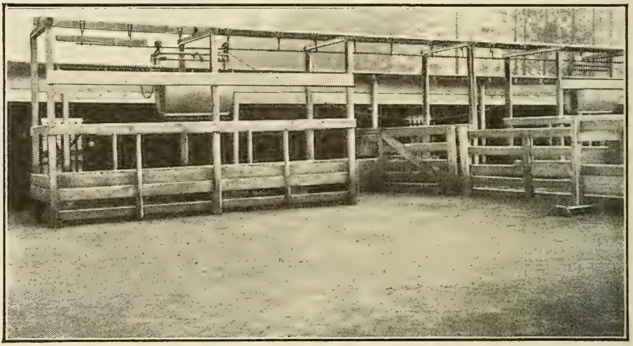
ing the stover or the silage. In addition to this some of the legumes should be fed. It is a poor system of farming that will not admit clover, cowpeas and soy beans, even though alfalfa has not been successfully grown

The roughage materials successfully grown in a community are satisfactory basic foods for growing beef. The art will rest with their employment in feeding rations in connection with other balancing foods to give the right balance. Cattle should not simply have thrown before them such foods as are at hand. These foods should be so prepared and balanced as to provide the necessary food nutrients in the proper proportion that cattle of the specific age shall demand.

**Leading Grain Foods.**—Corn is first in the list of grain products. It is fed in many forms—ground, shelled, on the ear, crushed with the cob, in the shuck, and green on the stalk. So universally is it grown and so readily adapted is it to practically all sections that it will continue to be the chief grain provided in most rations for feeding steers for beef. It carries much starch and oil, and is therefore largely a fattening food. It stands high nevertheless as a growing or developing food, but being somewhat lacking in protein, it is not and should not be considered an exclusive grain for growing animals.

Fortunately there is a wide choice of supplementary concentrates to use in connection with corn. Chief among these for steers are, cottonseed meal, linseed oil meal, soy bean meal, wheat bran, the

glutens, and various by-products of starch and cereal factories. It is unnecessary here to record the long list of grain products that enter into the production of beef. Some are local feeds; some are prohibitive because of their value for other purposes; and some, while good and available, are ordinarily outclassed as fattening foods because of the better qualities and larger supply of such grains and concentrates, as previously mentioned.



Track Contrivance for Feeding Cattle

The grain is prepared and mixed in the barn and later delivered by means of the track and cars to the feeding pens. In this way much labor is saved.

Whether grains shall be ground, crushed or fed whole, or whether they shall be fed on pasture or in the feed lot, in outside racks or in closed stalls, will depend upon circumstances, the management of the farm and the nature of the man. What is most important of all is to grow as much corn as can be profitably grown; to grow as much roughage as the method of farming will admit, and to have as much of this of a legume nature as possible; to

use home-grown corn to feed in connection with this roughage; and, finally, to supplement roughage and corn with other concentrates purchased outright or secured in exchange for corn and fed in such ways as will give balanced rations to meet the ever-changing needs of the steers under feed.

## SOME SAMPLE RATIONS

### Maintenance Ration for Breeding Cows.

The following rations are for cows during the winter and without calves:

1. Corn silage, 20 pounds; clover hay, 3 pounds; oat straw, 10 pounds.
2. Shock corn, 8 pounds; clover hay, 3 pounds; oat straw, 10 pounds.
3. Shredded stover, 10 pounds; clover hay, 5 pounds.

### Winter Yearlings With and Without Grain.

1. Corn silage, 15 pounds; clover hay, 15 pounds.
2. Clover hay, 10 pounds; corn stover, 10 pounds; corn, 3 pounds.
3. Timothy hay, 8 pounds; clover hay, 8 pounds; corn, 3 pounds.
4. Alfalfa hay, 10 pounds; corn, 5 pounds.
5. Cowpea hay, 10 pounds; corn, 5 pounds.
6. Clover hay, 14 pounds; corn, 3 pounds.
7. Alfalfa, 7 pounds; corn stover, 6 pounds; corn, 3 pounds.

**Rations for Fattening Steers.**

1. Shelled corn, 21 pounds; cottonseed meal, 2 pounds; clover hay, 4 pounds; corn silage, 15 pounds.
2. Corn, 22 pounds; alfalfa hay, 5 pounds; corn stover, 5 pounds.
3. Corn, 14 pounds; alfalfa hay, 10 pounds; corn stover, 7 pounds.
4. Ear corn, 20 pounds; gluten or oil meal, 3 pounds; clover hay, 8 pounds.
5. Ear corn, 13 pounds; oil meal, 2 pounds; shock corn, 15 pounds; clover hay, 7 pounds.
6. Kafir corn, 15 pounds; cottonseed meal, 3 pounds; cottonseed hulls, 13 pounds.
7. Corn, 15 pounds; cottonseed meal, 3 pounds; mixed hay, 10 pounds.
8. Cottonseed hulls, 25 pounds; cottonseed meal, 6¼ pounds.
9. Alfalfa hay, 9 pounds; corn, 18 pounds.
10. Corn silage, 24 pounds; mixed hay, 5 pounds; shelled corn, 15 pounds; cottonseed meal, 2 pounds.
11. Corn silage, 30 pounds; shelled corn, 16 pounds; cottonseed meal, 3 pounds.
12. Cassava, 35 pounds; peavine hay, 10 pounds; cottonseed meal, 4 pounds.

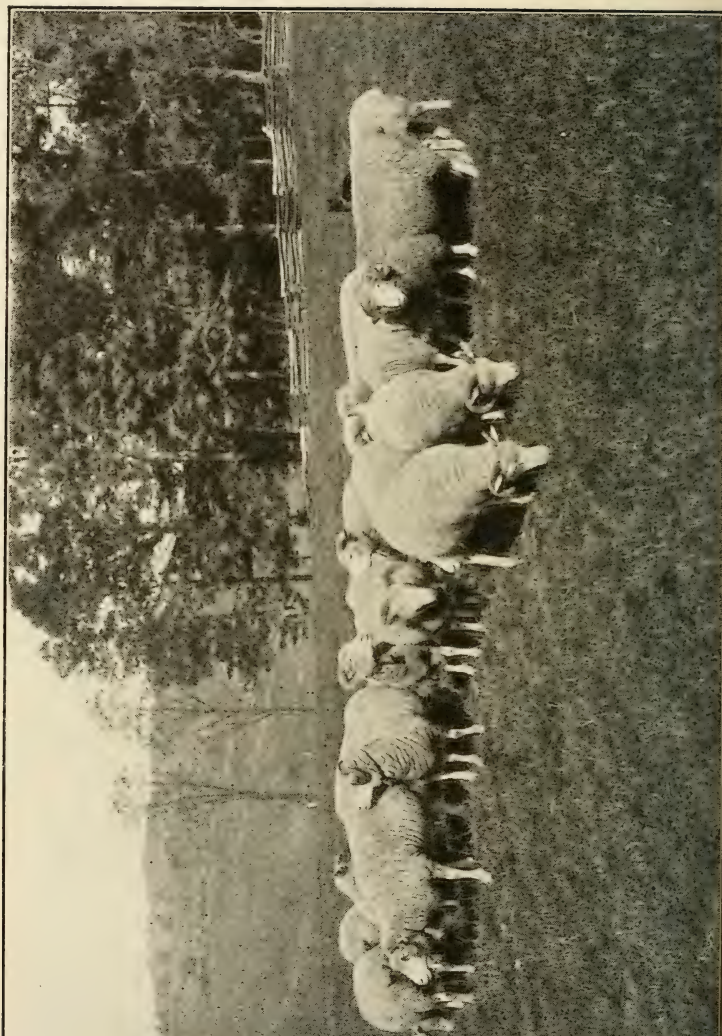
## CHAPTER XIX

# FEEDING SHEEP

**Food Requirements for Sheep.**—The Wolff-Lehmann standards for feeding the various classes of sheep are shown in the table below. They indicate the amount of food required per 1,000 pounds live weight for both wool and mutton, and for growing, mature and fattening sheep.

WOLFF-LEHMANN STANDARDS FOR FEEDING SHEEP

| Kind of sheep | | Dry matter | Digestible nutrients | | | Nutritive ratio |
|---|---|---|---|---|---|---|
| | | | Protein | Carbo-hydrates | Fat | |
| Growing sheep Wool breeds | | | | | | |
| Age in months | Weight | | | | | |
| 4 to 6 | 60 | 25 | 3.4 | 15.4 | 0.7 | 1:5.0 |
| 6 to 8 | 75 | 25 | 2.8 | 13.8 | 0.6 | 1:5.4 |
| 8 to 11 | 80 | 23 | 2.1 | 11.5 | 0.5 | 1:6.0 |
| 11 to 15 | 90 | 22 | 1.8 | 11.2 | 0.4 | 1:7.0 |
| 15 to 20 | 100 | 22 | 1.5 | 10.8 | 0.3 | 1:7.7 |
| Growing sheep Mutton breeds | | | | | | |
| 4 to 6 | 60 | 26 | 4.4 | 15.5 | 0.9 | 1:4.0 |
| 6 to 8 | 80 | 26 | 3.5 | 15.0 | 0.7 | 1:4.8 |
| 8 to 11 | 100 | 24 | 3.0 | 14.3 | 0.5 | 1:5.2 |
| 11 to 15 | 120 | 23 | 2.2 | 12.6 | 0.5 | 1:6.3 |
| 15 to 20 | 150 | 22 | 2.0 | 12.0 | 0.4 | 1:6.5 |
| Mature sheep | | | | | | |
| Coarse wool .. | | 20 | 1.2 | 10.5 | 0.2 | 1:9.1 |
| Fine wool ... | | 23 | 1.5 | 12.0 | 0.3 | 1:8.5 |
| Breeding ewes with lambs .. | | 25 | 2.9 | 15.0 | 0.5 | 1:5.6 |
| Fattening sheep | | | | | | |
| First period .. | | 30 | 3.0 | 15.0 | 0.5 | 1:5.4 |
| Second period | | 28 | 3.5 | 14.5 | 0.6 | 1:4.5 |



THE PASTURE IS GOOD AND THE SHEEP ARE

**Wool and Mutton.**—The food consumed by sheep is used for both flesh and wool. Hence, these animals have a double requirement to meet. Wool contains much nitrogen, and a slightly more liberal supply of protein is demanded than for either swine or beeves. Sheep, too, are very active creatures; their body surface is proportionately greater than that of beeves. Because of this they require more food, proportionately.

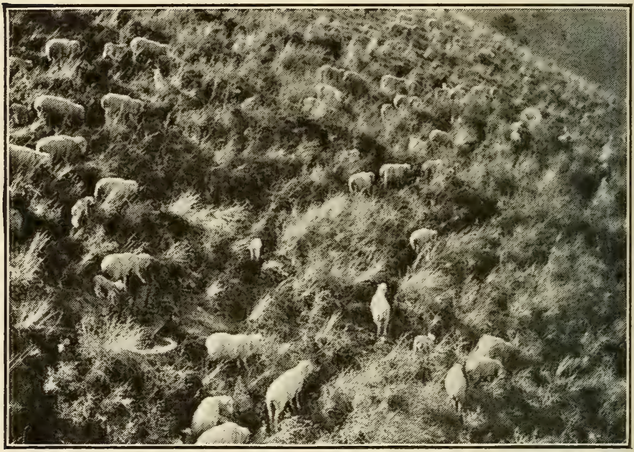
The larger breeds of sheep require about one pound of digestible protein to eight pounds of starch equivalent, the smaller breeds slightly more. The wool growth becomes less active as the food supply is reduced, but if more food is given than the animal has use for, the rate of wool growth will not be increased.

**Relative Economy of Sheep, Steers and Pigs.**—Compared with swine, the sheep does not render quite as good an account of its food as does the pig; in fact, it requires nearly twice as much digestible organic matter to produce 100 pounds of gain. While this is true, it is not to be forgotten that much of the sheep's provender is in the form of hay or other roughage and of a nature that the pig could not use. Pigs demand easily digested food, and that largely in the form of grain. From the point of profit, therefore, the sheep is not at a disadvantage at all.

Compared with steers, sheep have slightly the better of it. Nearly 50 years ago Lawes and Gilbert determined that, covering a whole fattening period, a steer, to produce 100 pounds of increase,

requires 3,500 pounds of swedes, 600 pounds of clover hay and 250 pounds of oil meal. To produce the same increase these investigators found that sheep require 4,000 pounds of swedes, 300 pounds of clover hay and 250 pounds of oil meal. The advantage as between steers and sheep was slightly with the latter.

**Wide Variety of Feed for Sheep.**—The variety of



SHEEP RANGE IN THE NORTHWEST

foods suitable for feeding sheep is extensive. Hay, straw, corn stover, roots of various kinds, corn, oats, peas, rye, buckwheat, cottonseed meal, linseed oil meal, and bran furnish a variety from which a proper choice can readily be made. The relative feeding values of these various substances used as food will determine the relative money values, and as these differ and fluctuate from time to time, it is

often necessary, in order to secure the most profit on the feeding, to choose the food that is most economical to use, although it may be the highest in price. Cottonseed meal, while one of the highest priced concentrates on the market, is at the same time a heavy carrier of protein, and when a roughage material like corn stover or timothy hay is fed, cottonseed meal is really a cheaper food than corn at a much less cost. It is not only advisable, but very profitable, to pay a higher price for this grain than for other less heavy protein carriers, even at prices considerably less.

The two most valuable feeds for winter use are clover and alfalfa. Cut when in blossom, cured so as to preserve all good qualities and kept from damp and mold, each of these is a good basic food for all feeding purposes, and where a maintenance diet is desired each will practically meet the requirements without any additional supply. Well-cured pea straw comes third in the list, and is liked by sheep better than either timothy or any other grass or cereal hay.

Oat hay, if cut when the grains are in the milk stage, is much liked and is an admirable feed for sheep. Fodder corn is greedily eaten, blades, husks and ears, the hard stalks only being rejected. When fodder corn is fed, some protein food like oil meal, bran, pea meal, or a mixture should be fed in addition.

**Choosing the Feed.**—While there is wide choice as to the variety of food, those foods that furnish abundant flesh should be chosen for the grow-

ing classes, and those rich in starch and oil selected for fattening. The protein supply should be sufficient, else the body will not be properly supported, wool growth will be checked, and the readiest digestion of the carbohydrates and fats will not be secured. This last point must always be kept in mind in feeding any class of live stock.

Much may be gained by varying or mixing the food so as to stimulate the appetite. A healthy sheep will increase in weight in proportion to the food consumed only as long as digestion and assimilation are of a high order. If a sheep can be made to increase its diet by the addition of roots or appetizing concentrates, a manifest advantage is gained.

**Roots Always Fine for Sheep.**—Roots, a staple food, are of the greatest value in winter feeding of sheep. When fed in proper quantities, their laxative effect healthfully opposes the tendency of dry straw or hay to produce costiveness. If fed in excess, the quantity of water they contain and their large bulk, especially when used in winter, reduce the temperature of the animal considerably and gradually act unfavorably on the health. Watery foods are not good for sheep. Sheep need succulence, but roots and green crops should be considered as supplements only, and not as the basic portions of the ration.

The roots most commonly fed are sugar beets, mangels, rutabagas and turnips. Each kind is favorable in effect upon the quality of the wool. The quantity of roots to be given will depend on the kind of sheep. As a safe guide, it may be stated

that one bushel of roots will be sufficient as a daily allowance for 10 sheep weighing 150 pounds each, if along with the roots 1½ pounds of hay and ½ pound of meal or bran are given daily to each animal.

**Sheep Require Water.**—During the summer sheep frequently are put on pastures where water is not available. While they may be able to subsist under

TEMPORARY PASTURES BEST FOR SHEEP

If grazed over the same land year after year the pastures become infested with parasites. On permanent pastures sheep should be changed frequently. Temporary pastures of timothy and clover provide rich forage and the constant turning of the land by the plow keeps the parasites in check.

these conditions they often suffer, and even perish, from lack of water. So long as heavy dews gather on the grass considerable water is taken into the system and its demand is in this way met, but in the hot summer, when dews are infrequent or totally lacking and pastures are dry, there is a decided need for water. This must be provided if satisfactory

growth is to be secured. It is an old fallacy that sheep do not need water.

**When Turning to Pasture.**—Change from dry forage to fresh pasture gradually. An afternoon is best when no moisture is on the grass. After feeding on this pasture for a short time return the flock to the yard. Repeat in this manner for a few days, and little if any digestive disturbances will arise. After four or five days the sheep will become accustomed to green feed.

**Proportion of Grain to Roughage.**—Practical feeders have found no definite rule to use in this matter. If grain is abundant and hay scarce, more grain is fed than when the opposite condition obtains. For economical gains the roughage material will be fed in as large quantities as the animals may be induced to eat. Some grain, however, is necessary. The amount will vary from 1½ to 2 pounds of roughage to one pound of grain. Under average feeding conditions about 300 pounds of grain and 500 pounds of roughage will be required to give 100 pounds of increase. If on blue grass or rape pasture, about 175 pounds of corn should secure 100 pounds of gain.

**How Often to Feed Sheep.**—Usually sheep, when being fattened, are fed twice each day. Slightly better returns have been observed when three feeds are provided. The gain is not large, but it is frequently sufficient to meet more than the cost in labor and trouble.

**Feeding Corn in the Field.**—When sheep are at pasture ear corn may be scattered about, two or

three bushels each day to each 100 sheep in the flock. The corn should be thinly scattered, and fed half in the morning and half at night. This practice may be followed during any season of the year.

**Rape an Excellent Sheep Feed.**—This splendid forage crop combines well with corn. Where corn in the field is fed off, it is desirable that rape be seeded in the field at the last cultivation. Ordinarily, the sheep will blend the two feeds, consuming

Sheep on Rape Pasture

both corn and rape. If rape is seeded separately and sheep turned on it to graze, the addition of one to two bushels of corn a head during the fattening period of 100 days is to be commended.

**Roughage Feeds.**—Pasture is entitled to the first place of good roughage feeds. It may consist of alfalfa, clover, mixed grasses, or blue grass. After these come the roots and rape. Each has its place. Cured as hay, naturally alfalfa and clover fall in the

first rank, and are always to be preferred for lamb feeding, fattening ewes or wethers, or during the lambing season. In their absence the mixed hays may be used, but heavier grain feeding will be necessary, particularly at lambing time.

**Temporary Fences by Means of Hurdles.**—In grazing forage crops like peas and rape, temporary fences in the form of hurdles may be used. These hurdles are moved forward every few days, providing in this way a strip of fresh pasture. Otherwise, if given the run of a field, much forage will be destroyed and soiled by tramping. Move the hurdles before the eaten-over portion has been cleaned up.

**Putting Sheep on Full Grain Rations.**—If grain has been fed while sheep are at pasture, it is an easy matter to change from pasture to yard and put on fattening rations. Beginning with a fourth of a pound of grain daily, the amount may gradually be increased by a fourth of a pound the second week, and so on. At the end of the fourth week the animals should be cleaning up a pound or more of grain each day. By the end of two months a daily allowance of 1½ or 2 pounds may be fed. It is seldom advisable to feed more than two pounds of grain a head daily. The good shepherd watches his sheep and observes the first indication of bad appetite. When noticed, he corrects the trouble at once.

**Green Crops for Roughage.**—Sheep are most at home in pasture fields. They feed not only on the tender grass blades, but they strip weeds and other foul plants of their leaves and branches. They are in truth the plant scavengers of the farm. But kept

on the same land in the same field year after year without change the pastures become foul, disease lurks in the soil and dangerous parasites accumulate. For these reasons sheep should be changed frequently from field to field, from year to year, and except in the case of well-established permanent pastures, crop rotation should be followed so the fields may be clean of disease or parasites and may be ever fresh with new-growing grass crops.

Over a good part of the country timothy and clover, with red top and alsike or white clover occasionally mixed, comprise much of the pasture land. The prairie grasses of the west and Bermuda grass of the south take care of the local needs in these parts of the country. Blue grass is the stand-by of the old grazing sections; in addition to it other crops may find place and may be profitably grown. Rye seeded in August makes a fairly good pasture for lambs and old sheep in the fall. It will furnish excellent grazing in the spring before the clovers, alfalfa and blue grass are available.

**Some of the Best Grains.**—Corn stands first because it is so universally grown. It is well liked by sheep and makes profitable gains. It may be fed in the husk, on the stalk, in the feed rack, in the field, crushed, ground or shelled. Some feeders dislike to use corn when finely ground, because sheep eat it too greedily. Ear corn is satisfactory for winter yearlings and ewes.

Oats are fed to some extent, but they should be ground or crushed. They make excellent feed for either lambs, or ewes in milk. Compared with many

other feeding stuffs oats are rather expensive, and for this reason they often give way to linseed oil meal, cottonseed meal, soy beans, and wheat bran. Wheat bran, being bulky, is splendid to use in a mixture with the oil meals.

Wheat screenings, where available, give good returns. Not many years back screenings were a principal part of fattening rations. This food product has been very largely taken over by stock food and commercial food factories, thus leaving only a small amount for sheep feeding. Screenings are

OUT AT PASTURE

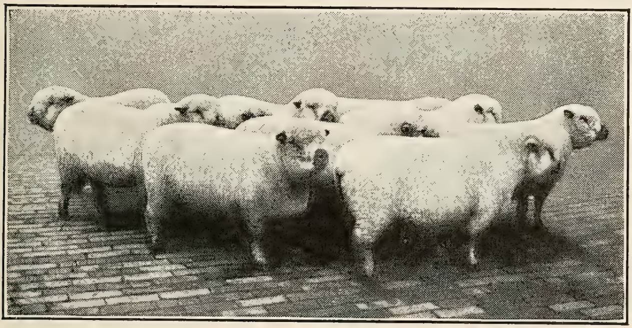
The sheep have been kept thrifty by wise feeding and careful attention. Both ewes and lambs are together.

ground and mixed with various weed seeds and other by-products of the cereal food factories. The price at which these foods are sold is high and usually out of proportion to the price that sheep bring in the market.

With the breaking up of large flocks, sheep will be raised more and more in small flocks on small farms of 50 to 100 acres. On such farms they will have the run of the temporary pastures, will be fed

the hay crops ordinarily raised on the farm, will be supplied to some extent with silage, and fattened on rape, cowpeas, soy beans, corn, oil meal and cottonseed meal and the ordinary roughage materials customarily grown on each farm.

**Feeding Lambs for Market.**—For most markets the feeding process begins late in the fall or the early winter. In addition to late fall pasture, such as rye, rape, new growth of blue grass, young clover or al-



READY FOR MARKET

Their ration consisted of clover hay, oil meal, ground oats, and corn.

falfa, lambs will have been using in many instances leguminous hays or other dry fodder, so that by the time they are actually confined in close feeding pens and placed upon a fattening ration their digestive systems will have become accustomed to dry feed. So handled they will be in condition to use economically large amounts of forage and grain, and should gain from the first week after being placed in confinement.

Roots and succulent feeds are not essential in successful lamb feeding. Experiments indicate that under some conditions these feeds may be detrimental to the most economical gains. It is a mooted question and will have to be worked out by every feeder. A well-balanced ration consisting of hay and grain, plenty of water, regular feeding and comfortable quarters are the factors that produce nearly all the fat lambs. Alfalfa is beyond question the best forage, but in its absence clover, cowpeas or other leguminous forage is a good substitute and practically indispensable. If such forage is not at hand, then sugar cane, kafir corn, millet or mixed hay, cut at the proper period and carefully cured, will give good gains, although more grain will be necessary.

The grain ration will consist largely of corn. Cracked corn is usually preferred to whole corn. Small amounts of oil meal, ground oats, or both, may be introduced into the ration with good effect; if a leguminous hay is not used, one of them should certainly be added. Lambs should weigh about 60 pounds when placed in the feed lot. After a feeding period of 60 to 90 days they should weigh from 90 to 95 pounds. Often heavier weights than these are obtained, but when a lamb weighs more than 100 pounds he is likely to be discriminated against by buyers and may possibly have to be sold for a sheep instead of a lamb, at a lower price.

**Fattening Grown Sheep.**—The feeding of wethers or grown ewes for market does not differ much from the method employed in fattening lambs. On some

farms lambs are held over a season to utilize plentiful pasture and to secure one or two wool clips. Such sheep also weigh more at market time, although they bring a smaller price per pound. These older sheep, kept on good pasture throughout the summer and placed in the feed lot in winter, usually make excellent use of grain and hay. They may be marketed during late winter or early spring.

Poor Way to Feed Sheep

On many farms corn is fed to sheep on the ear and stalk. This is a disappearing custom. When so fed a clean pasture is the best place to scatter the feed. Even then a large amount of fodder is wasted, for sheep will not eat what has once been run over.

Concentrated feeds are essential. They should be used in connection with bright, clean leguminous hays and so mixed with the hay as to give a well-balanced ration. Corn, bran, ground oats, oil meal and cottonseed meal, are all excellent. During early winter, corn silage and alfalfa or clover hay may be fed exclusively. In other cases fodder corn and

mixed hay may be used for roughage, with wheat bran and corn for grain, about ½ pound of a mixture of corn and bran being given daily to each animal. As they plump up, the grain may be increased gradually, until it reaches as much as two or even three pounds a day.

Where alfalfa or clover is used, a pound of corn daily will be satisfactory. If alfalfa or clover is freely used and corn is relatively low in price and hay high, then cut down the allotment of hay and feed one or two pounds of corn daily. Where some grass hay or corn stover, shredded or unshredded, is the only source of roughage, bran and one of the oil meals should be used in addition to the corn. If fed throughout the winter in this manner, a heavy wool clip may be secured the following spring before the animals are marketed. Thus satisfactory profits will ordinarily be secured.

## SOME SAMPLE RATIONS

### For Lambs Weighing 50 to 60 Pounds.

The following rations, in common use, secure satisfactory gains. The amount of feed here suggested is for flocks of 50 and the daily allowance for all:

1. Mixed hay, 50 pounds; roots, 50 pounds; corn, 45 pounds; oats, 6 pounds.
2. Mixed hay, 50 pounds; roots, 50 pounds; bran, 25 pounds; linseed meal, 20 pounds; cottonseed meal, 15 pounds.
3. Cottonseed hulls, 60 pounds; cottonseed meal, 40 pounds.

**For Lambs Weighing 60 to 80 Pounds.**

In flocks of 50 and daily allowance.

1. Corn, 75 pounds shelled; clover hay, 50 pounds.
2. Corn, 40 pounds, shelled; bran, 40 pounds; clover hay, 50 pounds.
3. Oil meal, 15 pounds; corn, 65 pounds; clover hay, 50 pounds.
4. Alfalfa hay, 125 pounds; corn, 35 pounds.

**For Lambs Weighing 80 to 100 Pounds.**

In flocks of 50 and daily allowance.

1. Pasture and 40 pounds of corn.
2. Pasture and 35 pounds of oats.
3. Clover hay, 85 pounds; corn, 45 pounds; gluten, 20 pounds; bran, 10 pounds.
4. Clover hay, 85 pounds; bran, 10 pounds; soy beans, 65 pounds.

**For Sheep in Winter.**

1. Corn silage and alfalfa or clover hay.
2. Roots, 5 bushels; hay, 75 pounds; meal or bran—use 25 pounds for a flock of 50 sheep.
3. Fodder corn, mixed hay and wheat bran and corn, with not more than a half pound of grain per animal.

**Sheep on Full Feed.**

1. From a quarter to a half pound of clover hay and from 2½ to 3½ pounds of grain each daily.
2. Alfalfa, 2 pounds, and ¾ of a pound of corn each daily.

3. Hay, 1¼ pounds, and corn 1 to 3 pounds each daily.
4. Free use of alfalfa or clover and 1 pound of corn daily when grain is costly and hay relatively cheap. If the reverse, limit the hay and feed from 1 to 2 pounds of corn daily.

**For Ewes with Lambs at Side.**

1. Corn silage, 4 pounds; mangels or other roots, 1 pound; and 1½ pounds of mixed grain, consisting of a mixture of 100 pounds of bran, 30 pounds of ground oats, 45 pounds of cracked oil cake, and 25 pounds of corn.
2. Alfalfa or clover hay, 2 pounds; corn, 1 pound; hay or oil meal, 0.5 pound.

# CHAPTER XX

## FEEDING SWINE

**Food Requirements for Swine.**—The Wolff-Lehmann standards for feeding the various classes of swine are shown in the table below. They indicate the amount of food required per 1,000 pounds live weight and are for growing pigs, brood sows and fattening hogs.

WOLFF-LEHMANN STANDARDS FOR FEEDING SWINE

| Growing swine Breeding | | | Digestible nutrients | | | |
|---|---|---|---|---|---|---|
| Age in months | Weight | Dry matter | Protein | Carbo-hydrates | Fat | Nutritive ratio |
| 2 to 3 | 50 | 44 | 7.6 | 28.0 | 1.0 | 1:4.0 |
| 3 to 5 | 100 | 35 | 5.0 | 23.1 | 0.8 | 1:5.0 |
| 5 to 6 | 120 | 32 | 3.7 | 21.3 | 0.4 | 1:6.0 |
| 6 to 8 | 200 | 28 | 2.8 | 18.7 | 0.3 | 1:7.0 |
| 8 to 12 | 250 | 25 | 2.1 | 15.3 | 0.2 | 1:7.5 |
| Growing swine Fattening | | | | | | |
| 2 to 3 | 50 | 44 | 7.6 | 28.0 | 1.0 | 1:4.0 |
| 3 to 5 | 100 | 35 | 5.0 | 23.1 | 0.8 | 1:5.0 |
| 5 to 6 | 150 | 33 | 4.3 | 22.3 | 0.6 | 1:5.5 |
| 6 to 8 | 200 | 30 | 3.6 | 20.5 | 0.4 | 1:6.0 |
| 8 to 12 | 300 | 26 | 3.0 | 18.3 | 0.3 | 1:6.4 |
| Brood sows .... | | 22 | 2.5 | 15.5 | 0.4 | 1:6.6 |
| Fattening swine | | | | | | |
| First period .. | | 36 | 4.5 | 25.0 | 0.7 | 1:5.9 |
| Second period | | 32 | 4.0 | 24.0 | 0.5 | 1:6.3 |
| Third period.. | | 25 | 2.7 | 18.0 | 0.4 | 1:7.0 |

**Hogs Consume Much and Give Generous Returns.** The hog is at home with poor and rich; he works

BUNCH OF HOGS READY TO BE SLAUGHTERED

energetically for both. Whether inclosed in muddy pens or given the range of wide acres, he neither frets nor pines. He grows the best he can, increases his size as rapidly as his food supply admits, and invariably pays his way. As a consumer of food he eats greedily and heartily, but the account he furnishes is honest. He is wasteful of what he eats only when he is denied what he wants and in generous quantities; but, fed abundantly, he grows fat, matures rapidly, and manufactures meat and lard economically.

The fact is, when compared with other meat producers, the hog consumes less food for what he gives than any other meat-making animal. He works faster. It is due in part to his digestive apparatus, to the kind of food he relishes, and to the fact that he uses less food than the other animals for work and body heat. On the basis of 1,000 pounds live weight the hog uses about 275 pounds of dry food to 160 for the sheep and 125 for steers a week. Of this he will digest 230 pounds, while the sheep will digest but 120 pounds and the steer but 88 pounds.

To produce 100 pounds of increase the steer will consume 1,100 pounds of dry food, the sheep 910 and the hog 420. The increase in live weight for food consumed, on the basis of one point for steers, will be 1.5 for sheep and 5.8 for hogs. From this it is

clear that in proportion to its weight the sheep eats more food than the steer and yields a greater increase in consequence; but the pig, by eating more heartily, consumes more food and yields more meat or increase than either.

**Fastest Gains Are Made During Early Growth.**— It used to be that hogs were kept as stockers on grass until they had reached a year or two in age, and then be fed until they weighed from 300 to 500 pounds. When slaughtered or sold they, of course,

THEY ATE MUCH AND DEVELOPED RAPIDLY

The hog consumes less dry food to produce a given increase than either the sheep or the steer. He is therefore our best meat maker.

showed great returns, but the cost of bringing up to such weights was not considered. When put to the test it was soon realized that while such hogs in the feed lot would take on a large increase, the cost of the increase was far above the returns in money. In other words, large hogs will steadily take on increase, but they do so only with great consumption of food.

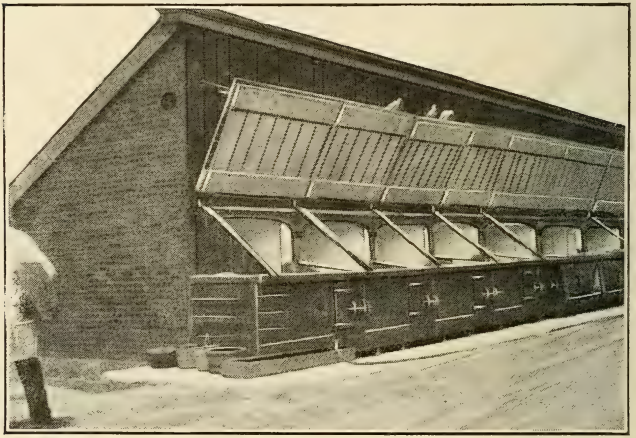
A pig of proper age and weighing under 100 pounds will require less than 300 pounds of feed to yield 100 pounds of increase, while a mature hog weighing 300 pounds will demand over 500 pounds of feed to yield 100 pounds of increase. There is, therefore, a decided economy in feeding hogs only up to a certain point. This point ranges from 175 to 250 pounds, depending on circumstances—the market price of hogs, and the sale value of feed. In these days few hogs are fattened by feeders until they attain a weight of 400 or 500 pounds. If they were, every pound of gain would cost twice as much as it would fetch in the market.

**Rations Are Narrow at First.**—The first food of the pig is milk; and milk is a narrow ration. Soon after birth additional food is demanded that will admit the gradual introduction of the carbohydrate ingredients. Middlings, shelled corn, or corn meal may each be profitably used. If skim milk is available, it will supply abundant protein, but corn meal, middlings or shorts should be added also. This combination is easily furnished as a slop, which may be continued even until the beginning of the fattening period.

The young pigs, during their suckling days, will do best if fed additional slop in a separate pen and away from the mother and the larger pigs. Runs in which are grown green grasses, the clovers and other forage crops are indispensable if pork is to be made at profitable returns. Provided for in this manner, the pigs will widen their ration in accordance with their needs.

The ration, which at first was very narrow, will now widen until spread to one part of protein to five or six parts of carbohydrates and fat. When the finish of the fattening period has been reached the ration will be near one of protein to eight or nine of the heat and fat-producing ingredients.

The great fattening food is corn: its nutritive ratio is one to nine plus. Thus the food changes in



VERY SANITARY AND VERY COSTLY

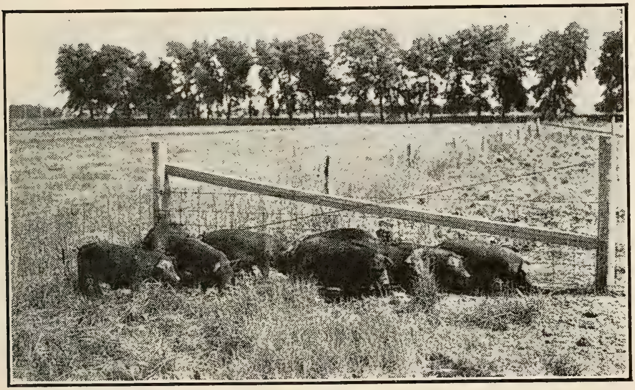
A hog barn of this order is the exception and not the rule. It is sanitary throughout, admits of easy feeding, and is easily cleaned.

character from milk to corn or other similar foods, and the ration is gradually widened to meet the increasing requirements for fat production.

**Mineral Matter and Charcoal.**—If the ration consists largely of corn, young hogs on pasture are not denied the necessary mineral elements to the extent that young pigs in the dry feed lot are. Pigs grow

rapidly if fed well; but if the food supply is deficient in the mineral elements, the lack is told in the ultimate results.

Ground bone or bone meal can be introduced advantageously into the ration either when the hogs are in the feed lot or on pasture. Soft coal, charcoal, and salt, either in mixture or given separately, should be kept before the animals at all times.



LEGUME PASTURES IDEAL FOR PIGS

For young growing pigs alfalfa, clover, or cowpeas are excellent forage crops. If one of these is not available, tender mixed grasses will serve. Corn or slop or both is advisable in addition to the green forage.

**Making a Slop.**—When pigs are young, food in the form of a slop is most easily and safely fed. At first it should be quite thin. The nearer it approaches the consistency of buttermilk the better for the pigs. As the pigs grow, it is a mistake to continue to feed a very thin slop. An oversupply of water in slop is harmful; fat production is thereby retarded. Consequently, if the food is given in this

way, the water is to be lessened as the animals increase in size.

When a weight of 100 pounds or so has been attained, the pigs now being five or six months old, the slop should be so made as to have a consistency somewhat like mush. If the pigs demand more water than this food gives, let it be available as drink.

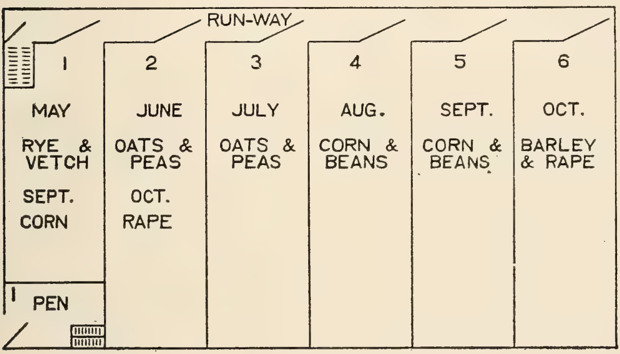
**Pasture for Pigs.**—The great opportunity for making a profit out of pigs, especially when prices are low and grain products high, is to depend on the use of clover, cowpeas, soy beans, alfalfa and rape pastures. As the subject of pig feeding is studied, more conclusive becomes the evidence that pasture crops go hand in hand with pork production. It should be the swine raiser's aim as much to grow these forage crops as it is to grow the hog itself. Particularly is this true of the legume crops. Alfalfa naturally comes first because of its highly digestible nutrients, its vigorous growth and consequent heavy yields, its long cycle of life and its land-improving benefits. In time alfalfa will be commonly grown in all sections.

Hogs may be turned into an alfalfa or a clover field early in the spring and kept there through the season until frost, provided the acreage is large in proportion to the number of animals. The tramping will not hurt the crop, and the grazing of the swine will not impair the feeding quality of the alfalfa when made into hay.

When a large field is pastured a portion can be cut, to be followed a week or so later by another portion, and so until the field has been cut over. In

this way there will be a new growth of alfalfa at all times, giving the pigs just the sort of pasture they desire. Alfalfa is rich in protein; hence the addition of corn to the ration while the animals are running on the pasture is advisable, especially if early maturity is sought. Young pigs on alfalfa, supplied with a light feeding of corn daily, within seven or eight months will weigh 250 pounds.

**Grazing Runs for Hogs.**—Where large fields are not available, small runs may be resorted to. These




Plan of Grazing Runs for Hogs

The hogs are shifted each month to a fresh pasture in which one of the best crops of the season is available as food.

solve the problem very satisfactorily on many farms. The small run lots may be of any size from a half acre to five acres. The number of hogs to be kept will govern both size and number of runs. An average size is about an acre. One or two of these lots may be permanent pasture of either clover or blue grass, a temporary pasture of timothy and clover,

or a permanent pasture of alfalfa. The other lots may be used in rotation. Several of them may be seeded to rye in the fall and as they are pastured off in turn during the winter and spring, they may be seeded with other forage plants. The one first grazed down may be plowed and seeded early to peas and oats, the next one to corn or sorghum or a mixture of the two, a third to cowpeas, and the others to soy beans, rape, peanuts and sweet potatoes.

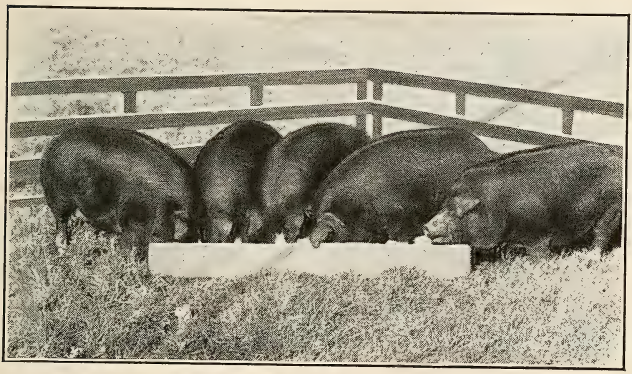
As each crop is pastured off, other summer crops may follow, thus giving a constant rotation of forage, and all as preparatory to the final finishing period. Hogs that have been brought near to the finishing period with cowpeas, soy beans, peanuts and sweet potatoes, should be finished off with corn, since the flavor of the meat will be improved and the fat will be less soft than it otherwise might be.

**Forage for Cheap Gain.**—Any growing crop is helpful in raising cheap pork. In sections where a temporary pasture like timothy and clover is the rule, spring pigs may be given the range of the fields. Thus they will gather a considerable portion of their food. They should not be denied, however, additional food in the way of slops or of dry grain. Corn, or corn and oil meal, or corn and tankage, may be used in combination to insure steady growth. Spring pigs thus raised by July will be of fair growth. From this time they should be pushed somewhat in order that they may be fat by late fall or early winter.

The feeding of green corn on pasture is a common practice and has much in its favor. Practically

all of the plant but the coarse stalk is consumed. The kinds of forage cover a wide range. The fact is, anything green that is appetizing is good for hogs.

**Fattening Hogs.**—The aim should be to get flesh growth rather than an overburden of fat. At the beginning of the fattening period hogs will eat 40 to

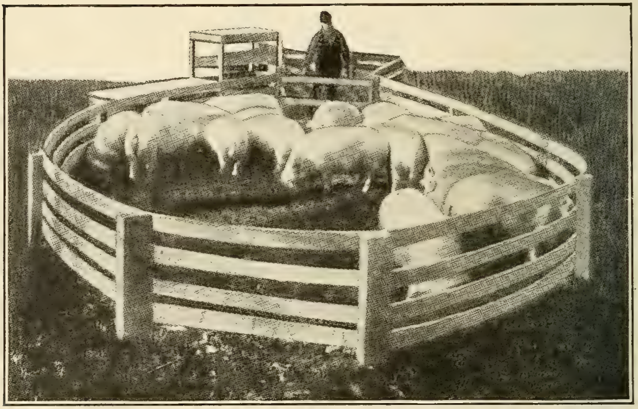


Enjoying the Charcoal Box

One reason why thrift is frequently wanting is due to an insufficient supply of protein and the mineral elements in the hog ration. A charcoal box, in which may be placed charcoal, soft coal, ground bone, salt and oil meal, meets the situation.

50 pounds of dry matter per 100 pounds of live weight. This diminishes to 25 or 30 pounds as the fattening period advances. Hogs will get fat on corn. Their best development is obtained only when other feeds containing more protein are given. Tankage, peas, or beans are excellent. Use one part of either to eight or ten parts of corn at the beginning of the finishing period.

The most intensive fattening is secured when easily digestible material is given. Corn is the universal food and enters most largely into the grain combination. All other grain feeds are to be used as supplements and as balancing foods to corn. During the beginning period of fattening, when clover, alfalfa or other pasture is available, corn is



GETTING THEIR RATIONS IN A PORTABLE PEN

The portable pen makes it possible to finish heavy hogs on clean feeding grounds. It is for outside feeding and should take the place of the stationary, filthy feeding lot.

the only grain necessary. Fattening hogs can be kept on such pastures almost up to the finish.

**Hogs Very Heavy with Fat** should not be required to roam about for food. Hence, during the final stage of fattening, the smaller the pasture or feed lot the less the loss because of this needless expenditure of energy. A great many of the most successful feeders take the fattening hogs from pas-

ture to the feed lot. In most cases corn is the exclusive feed. Water should be at hand at all times or available at frequent intervals. Rations containing one part of tankage or meat meal or soy bean meal to eight or ten parts of corn, unless corn is low in value, will produce a more rapid growth than corn alone.

**Making Good Bacon.**—Feeding stuffs greatly influence the quality of bacon. Oily grains have the strongest effect. To get good bacon, these oily grains should be reduced to a half or a third of the whole ration. Since corn is the principal food for both lard and bacon hogs, it may compose as much as 75 or 80 per cent of the ration. Middlings and tankage may be used for the balance.

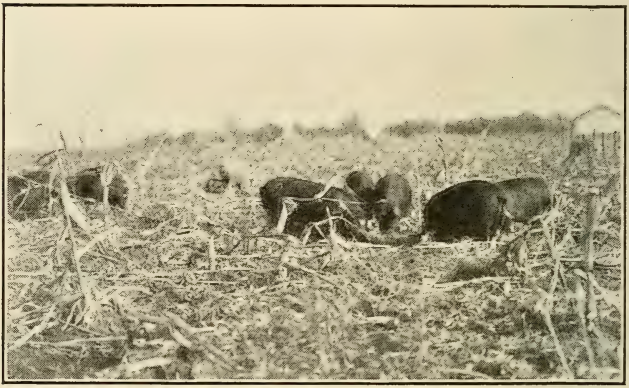
In Canada, where bacon is in much favor, barley is a common food for hogs. It is fed both ground and soaked. Other foods used in combination with it are skim milk, peas, oats and middlings. If oats are used they should be crushed. The most profit from bacon is secured when clover, alfalfa, cowpeas, or rape are provided as forage.

## HOGGING OFF CORN

**Hogs as Harvesters.**—The practice of getting fall hogs ready for market by turning them into the cornfield while the corn is still green is not new, but is a method not generally followed. There is a feeling that hogging off is wasteful and poor economy of labor and effort. The facts clearly indicate that the custom economizes labor and expense

and the hogs do better than by some other methods. That is the point: you get the most pork at the least expenditure of money.

Not only do hogs produce more with less grain in hogging off, but they actually mature in less time than when pen fed. It is not unusual to save at least a quarter of the fattening period where this method is followed. It is just as easy to prepare



Hogging Off the Corn

Hogs are here harvesting the corn crop. They not only eat all of the ears, but consume the greater part of the stalks. When the fat hogs are removed brood sows and pigs should be turned into the field to clean up.

land for a subsequent crop after a corn crop has been harvested by hogs as when the corn has been removed in the ordinary way. The hogs waste no more grain by hogging off than is lost by ordinary husking. Hogs pick just about as clean as huskers.

The labor item is not inconsiderable, either. A five to ten-acre field of good corn will carry 50 to 75 hogs from the shote to the finished period. Of course

the nature of the corn—whether the crop is heavy or light—will govern the number of hogs that can be fed in this way, but the total quantity of pork produced from a given acreage when hogged off will be greater than when husked ears or snapped corn is fed in pens.

**Young Hogs, Weighing 80 to 125 Pounds,** will do best in the green cornfield. At this size they possess good frames, are mature enough, and carry enough flesh to fatten in a few weeks and be ready for market. Of course, brood sows will make good use of green corn also. When thin from suckling pigs, or for any cause they are unthrifty, they will quickly flesh up and improve and be ready for market in from 30 to 50 days.

While corn may be hogged off at any period, it is best to let it mature somewhat. Then you get all there is in the crop. If the ordinary summer pasture is short, give some additional feed like shorts and middlings in slop to tide along until the corn is fairly well developed. When it has passed the milk stage, and is somewhat dented, the hogs may be turned into the field.

The entire field is usually given over to the hogs, when labor is high, the soil not wet, and the herd and the field not large in size. Use old hogs, stock hogs and brood sows for cleaning up after the fattening bunch has been taken away. Not much will be left, of course, but still some; if this were not so, the fattening hogs would have been fed rather unwisely for the last week or two.

## SOME SAMPLE RATIONS

### For Young Pigs.

When weaned and eight to ten weeks old:

1. Skim milk, crushed corn and middlings in equal parts by weight.
2. Thin slop of about the consistency of buttermilk, consisting of such ground grain feeds as are available. Use corn meal, ground oats, middlings, oil meal, etc. As the pigs grow older, gradually thicken the slop. When they are six or eight months old the slop should be like a thick mush.
3. **Pigs in Dry Lot.**—If milk is available, give 1 part of corn to 3 parts skim milk; if not, then 6 parts corn, 3 parts middlings and 1 part tankage.

### For Pigs Three to Six Months of Age.

Daily feed on basis of 100 pounds of live weight:

At three months: 3 pounds of corn meal; 1 pound of soy bean meal or 2 pounds of middlings; 5 pounds of skim milk; 7 pounds of water.

At four months: 4 pounds of corn meal; 0.8 pound of soy bean meal or 1 pound of middlings; 5 pounds of skim milk; 6 pounds of water.

At five months: 5 pounds of corn meal; 0.5 pound of soy bean meal or 0.75 pound of middlings; 5 pounds of skim milk; 3 pounds of water.

At six months: 4 pounds of corn meal; 0.4 pound of soy bean meal or 0.5 pound of middlings; 5 pounds of skim milk; 2 pounds of water.

**Pigs on Pasture.**—When pigs are allowed the run of a clover, cowpea or alfalfa pasture and weigh from 100 to 150 pounds, rapid gains will follow if a mixture consisting of 10 parts corn, 5 parts middlings and 1 part tankage be fed. If corn is low in price use 15 parts of corn to 1 part tankage or 2 parts oil meal.

**Fattening Hogs in Dry Lot.**—At the beginning of the fattening period give 6 parts corn and 3 parts middlings or 1 part tankage. When hogs have reached a weight of 180 to 200 pounds, give 8 parts corn, and 1 part tankage or other food of a protein nature.

## CHAPTER XXI

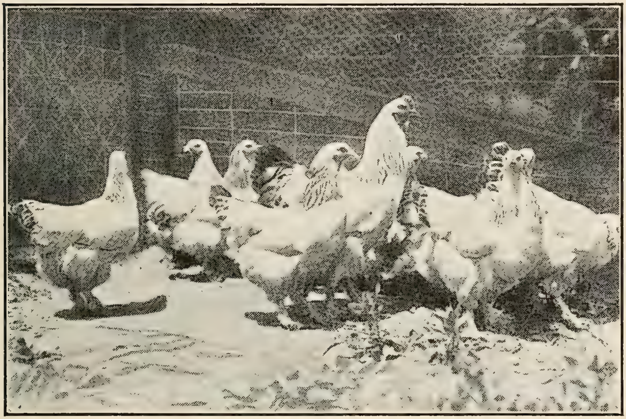
## FEEDING FARM POULTRY

Farm poultry is now a home necessity in every community. A few years ago the domestic hen was compelled to shift about and to get her food as best she could. Times have brought a change in this respect. The demand for eggs and poultry meat has been so great and so insistent as to make poultry raising one of the most profitable adjuncts to farming. On many farms, farm poultry now is exclusively the source of income, and all labor and crop production are directed to that end.

All fowls are greedy feeders. While they use food substances similar in form to what other classes of farm stock require, their food should be introduced in somewhat different ways. Rapid growth calls for much concentrated food; and where egg production is the aim, concentrated grain is demanded at all times. There is a need of much mineral matter for both growth and eggs. In a comparative way poultry calls for more of this than other kinds of live stock. There is less fat and more protein in poultry than in other meat-producing animals. In composition, eggs are similar to lean meat; hence, in feeding for eggs, a comparatively large amount of nitrogenous material should be available as food.

**Eggs Chemically Analyzed.**—The egg that the fowl produces is, next to milk, man's best food, the

most strengthening, the purest, the most unadulterable, the most healthful for young and old. Analyzed chemically, the white of an egg contains 85 per cent of water, the yolk 51 per cent of water and 31 per cent of fat. The shell is composed of phosphoric acid, lime, iron, sulphur and gluten.

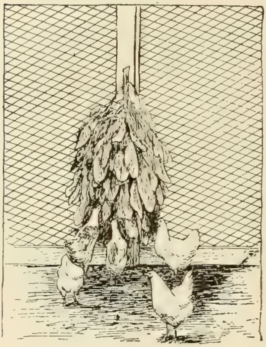


BUSINESS FLOCK OF LIGHT BRAHMA

These fowls, while the heavyweights of poultry varieties, require extra food because they are rather poor foragers. Hoppers of food should always be within reach.

**Various Rations Required.**—A variety of foodstuffs is to be preferred in feeding poultry, young or old. In many instances, single foods are given, but these cases usually apply to free range conditions when grass, seeds, insects and worms are picked up. If the entire country is taken into consideration, no doubt more farm fowls are fed on corn than on any other single foodstuff. On most farms there are certain by-products and damaged food,

like shrunken wheat grains and wheat screenings, that are set aside for the poultry, but as a general rule corn is the principal food, especially in the winter. Often wheat bran is given as a wet mash. Perhaps the grain that comes nearest meeting the requirement of a single food is wheat. On account of its commercial value, however, it is used sparingly, in combination with other food materials, or not at all.



GREEN FEED

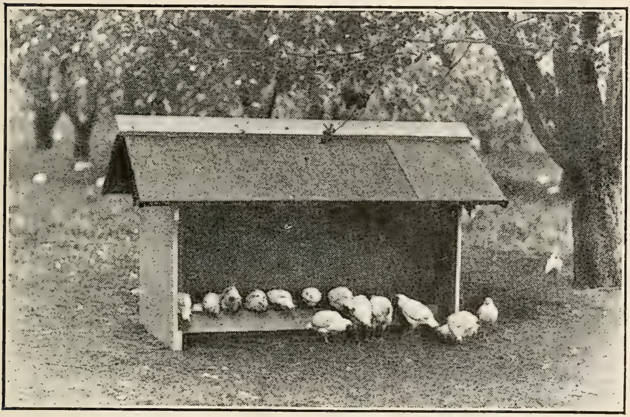
Rape, cabbage, mangels, etc., are necessary for fowls confined, and during winter. Fastening up as here shown is the best way to feed green stuff.

By means of variety a better balanced ration can be had than otherwise. Both poultry flesh and eggs are to be ranked with the lean meat products. While excellent results often come from the use of corn or from rations largely containing corn and other carbonaceous feeds, generally speaking, other products like wheat, bran, meat, oats, skim milk and green food are now accepted as poultry feeds, of the first class and are always desirable, especially for egg production in the winter season.

**Feed for Little Chicks.**—Perhaps there is no best way of feeding little chicks just out of the shell and for some time thereafter. Many plans are followed and all bring success, other conditions being satisfactory. Cooked and uncooked feed, baked and raw feed, wet and dry mashes are all used. So, too, are

many kinds and classes of food products selected. It largely depends on the conveniences available, the equipment and on the taste and peculiarities of the attendant.

It is more risky to feed moist or wet products than dry or crumbly dry ones to young chicks, because of possible digestive disturbances. For this reason dry



COMBINATION HOPPER FOR FIELD OR YARD USE

Beneath the hinged roof are compartments for various grains, grit, shell, charcoal, etc. Enough feed is put in these bins to last for several days.

cracked grain is generally preferred, even though wet mashes are introduced into the feeding plan at a later period. One method is to feed corn bread finely crumbed, five times a day, for the first few days. The bread is made of four parts of coarse corn meal to two parts of wheat bran, mixed with water, or milk, and baked brown. After the use of this for a week, a mixture of finely cracked and small grains is kept

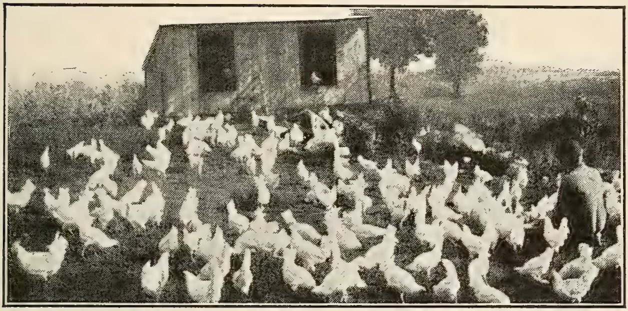
in shallow troughs where the chicks can help themselves. In addition to this ration sweet milk is fed every day when available. Green food should be furnished fresh. Lettuce leaves are excellent for young chicks. If allowed a grass run the lettuce is not needed, but skim milk is desirable.

Another plan is this: When the young chicks are 48 to 60 hours old they are fed hard-boiled eggs. They should be fed frequently in very small amounts. The eggs may be some of those tested out from the incubator or eggs otherwise unfit for use in the kitchen. Following this ration, place before the chicks in shallow pans a dry mash consisting of two pounds of corn meal, two pounds of shorts, two pounds of bran, two pounds of beef scrap and a half pound of charcoal. This ration may be fed until the chicks are of considerable size. The ration is now changed to two pounds each of millet, sifted cracked corn, cracked sorghum seed and cracked wheat. Of course, fresh water and clean grit should be before the chicks at all times. When they are large enough to eat whole grain, the cracked materials should be withdrawn. Chicks that are very early hatched, and those that have grown rapidly till midsummer should not have much beef scrap. If the young chicks are hatched very early, or if they mature unusually early, they may molt the first season. Both should be prevented, the latter by cautious feeding.

Commercial feeds for young chicks consist of various mixtures containing small grain, cracked corn, wheat, oats, millet, hemp, etc. They are not

different from what any poultry raiser himself can prepare at a cost considerably under what the retail merchant sells them for.

**Weaned Chicks on Good Range** may be fed a mash in the morning, with cracked corn, or other grain, or mixture of grains, scattered broadcast over the range, and the mash again in the evening. The mixture scattered over the range should be a day's allowance. Young chickens on good range are often



LEGHORN FLOCK AT RANGE

Nothing is better for poultry, especially layers, than free range on clover or alfalfa. The fowls not only get exercise, but gather a large quantity of protein in highly available form.

fed the table scraps mixed with corn meal, shorts and bran. These are served in equal parts, once a day. Cracked corn is kept in troughs or hoppers at all times.

A ration recommended by the Maine station for young chickens in brooders is as follows: Boil the infertile eggs for a half hour; grind, shell and all, in a meat chopper, and mix with rolled oats, six times the bulk of the eggs; feed with chick grit on

the brooder floor. If eggs are not available, beef scrap may be substituted and a ration consisting of the following given: Rolled oats, bran, corn meal, linseed meal, two parts each, and beef scrap, one part. After three days the following mixture is substituted: Cracked wheat, 15 parts; pin head oatmeal, 10 parts; cracked corn, 15 parts; cracked peas, three parts; broken rice, two parts; chicken grit, five parts; fine charcoal, two parts. No wet mash is given these chicks until three weeks old. After that age they are given wheat grain, two parts; corn meal, four parts; middlings, two parts; linseed meal, one part; beef scrap two parts. This mixture is slightly moistened with water and fed in troughs.

When chicks are five or six weeks old cracked grain may be omitted and wheat and fine cracked corn scattered in the litter.

**Feeding Larger Chicks.**—After chicks are five or six weeks old, the period of greatest danger is past, so far as the feed is concerned. They may now be fed less frequently and a greater variety of food may be given. A good mash is provided in ground corn, oats and bran, with a little salt. This should be fed once a day. Twice a week meat scraps or blood meal should be introduced into this mash. A small amount of bone meal or bone dust will not be out of place if fed daily.

Animal protein and bone material are both frequently denied on the farm; but this is due more to a lack of these materials as feed and knowledge of their need than either to carelessness or deliberate refusal. As the requirements of poultry feed-

ing are better understood this apparent neglect will be rectified. Young chicks, like other young animals, require much protein for muscles and feathers and much mineral matter for bone. Lime, while not necessary in such large quantities as for laying hens, should nevertheless be included in the ration.

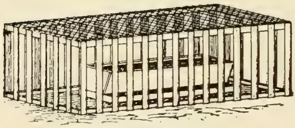
CRATE FEEDING FOR FANCY MARKET

A rather sloppy mash of milk and mixed meal, principally oats, is given the fowls two to four times daily for ten days or two weeks before killing. As the fowls have no exercise during this time they increase in weight and their flesh improves in quality.

Ground oyster shell is all that is needed. Charcoal should be kept before the young fowls. It is an inexpensive corrective, even if purchased, but usually it is available on the farm.

**Fattening the Cockerels.**—On most farms the cockerels are given the range of the field and are not

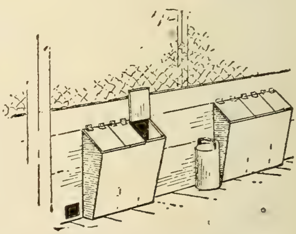
disposed of until late in the fall. Circumstances will govern as to what is best to do with them. Ordinarily it is less profitable to allow them to run at large than to confine them. On many farms the cockerels are separated from the rest of the flock when they have reached an age of five or six weeks and fed so as to reach an early market.



PROTECTED FEED TROUGH

Found useful where young and old fowls must run together. The openings between slats are too narrow for full-grown fowls to pass through.

Range chickens will eat a great deal of food, more than is generally supposed; and they use up a good deal of their muscle and flesh as they wander about. Where but few chickens are raised and these only for home use, this is a matter of small consequence; but if the cockerels are to be sold it is best to get them ready for market as early as possible and not to permit them to "run their flesh off" in seeking their food.



FEED HOPPERS FILLED FROM ALLEY

For convenience this plan is admirable. The hoppers discharge into the pens, but are filled from outside.

A good fattening ration consists of corn for grain and corn meal, bran and ground oats for mash. In preparing the mash, make it moist with skim milk if available. In case skim milk is not to be had, use meat scraps two or three times a week. Give at a feed about all the fowls will eat up clean, three times

daily. Grit and water are both indispensable, and some green food for variety will not be out of place.

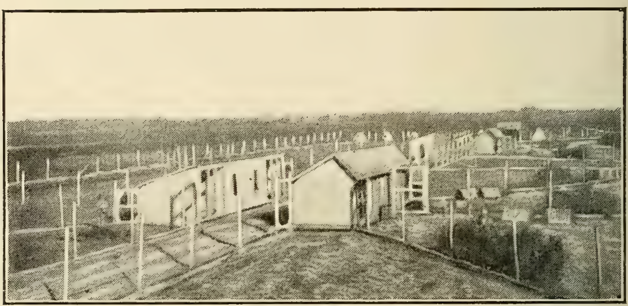
**Grain Feed for Fowls.**—For growing chicks and fattening fowls the grain should be ground. Opinions differ as to the necessity of grinding grains for egg production. Corn is the standard grain for chickens. The eggs resulting when it is largely used in the ration are of good quality, and the yolk is rich and of a strong yellow. Corn is also usually the cheapest grain. On account of its carbonaceous nature it is not a good food as an exclusive grain, either in fattening or in egg production. Buckwheat is very highly prized as a food for layers. It may be fed whole or ground. Kafir corn has been most satisfactory when fed whole. It ranks about with corn, which it resembles in composition.

For young chicks good poultrymen approve of rolled oats, but whole oats are not greatly relished by any class of poultry stock. If ground, they give good results in mashes wet or dry. Barley is liked by hens, and is superior to oats because of the smaller quantity of hull. Whole wheat or wheat screenings make an ideal ration for hens. Wheat is liked next to corn by poultry. It can be fed for indefinite periods without injury to the fowls. This is true also of wheat screenings.

The oil meals, on account of their concentrated nature, must be fed sparingly. These include the glutens, linseed oil meal and cottonseed meal. Linseed meal has been more generally fed than the others. There is not the demand for these meals in poultry feeding that there is for other stock, since

meat scrap is available and this takes their place to a great extent. Many other grains are fed to poultry with good success. It is not so much the kind of grain as the availability. Local grains and feeding stuffs share with the standard ones in all sections both in efficiency and popularity.

**Green Feeds.**—Lack of green food invariably affects egg production unfavorably. When flocks



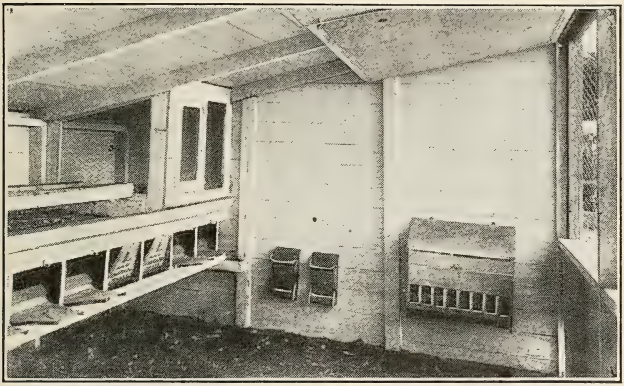
THE DOUBLE-YARDING SYSTEM

While the flock runs in one yard, rye, turnips, rape, or other green stuff is grown in the other, both to sweeten the ground and to supply forage for the fowls.

are at range they secure abundance, but flocks in yards and in winter quarters must be supplied. Green food may be fed at all times without stint. Among the best feeds are clover, alfalfa, grass, vetches, rape, rye, mangels, kale, cabbages, sugar beets, and turnips.

During the winter cabbage is especially useful. Root crops are good also. The leaves and broken heads from the hay mow may be steamed if desired. Kale and alfalfa contain large amounts of

protein and ash, the latter and clover giving quality to the eggs. Sprouted oats fed during the winter time have brought favorable results, but are more costly than other green feeds mentioned. They are fed two or three times weekly, or more often. A warm room, sunshine and close attention are necessary if they are to be grown in amounts called for to supply succulence and green feed.



INTERIOR OF WELL-ARRANGED POULTRY PEN

Note trap nests beneath roosts on left, cock or broody hen coop in corner, feed hoppers on the wall, open front at right and cloth screen for window pulled up to ceiling.

During the growing season, if hens are kept inclosed, either runs should be provided where they can obtain the green food, or the green food should be daily given, just as it would be given live stock when the soiling system is practiced. While alfalfa and clover meals are excellent for hens, they are not complete substitutes for green products. Both are rich in protein, and are therefore valuable foods;

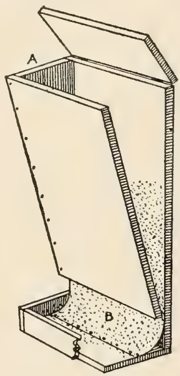
they cost a good deal more than the green products, and are not real substitutes. For winter feeding, especially for high-priced eggs, they can be introduced into the ration, provided their cost is not too great. Where grains and meals are extensively used in winter, even though the eggs bring high prices, the cost of production may not meet the labor items, and hence may overbalance all the profit.

**Meat or Animal Feed Important.**—Animal food of some sort is believed to be necessary to maintain fowls in vigorous health and productivity, whether the aim be flesh or eggs. Probably no one thing has done more to increase profits than feeding animal food. Scarcity of eggs during the winter is largely due to deficiency in this line. Chickens when at liberty during the summer secure abundant animal food in the form of bugs and worms. Something to take the place of this food is necessary, especially when the snow is on the ground. Fresh meat scrap from the butcher shop is an excellent egg maker.

On many farms bone cutters are run by hand or power, depending on the number of chickens kept, and fresh meat and bone are given the poultry at regular intervals. Bone is eaten just as greedily as the scraps of meat. The call for mineral matter is met to some extent in the bone supply. Doubtless the most convenient form in which to feed animal food is beef scrap or meat scrap, a boiled and dried by-product of the large packing houses. As it reaches the poultryman it contains meat and bone in varying proportions, which should analyze 50 to 60 per cent protein. It also varies in quality, but

should be light colored always, have a meaty flavor, and be rather oily to the touch. When boiling water is added to it, it should smell like fresh meat. If a putrid odor is given off it should not be fed.

**Grit Is Necessary.**—At all times chickens need grit, regardless of its function—whether it grinds the food or in itself is food, it matters not. The fact is, grit is absolutely essential, and fowls are in search of it at all times if not otherwise provided. Repeated tests have been made with and without its use in the ration and all have shown conclusively that it is indispensable to the health of the fowls and to egg production. When gravel is close by the grit question is easily answered. If the gravel is scarce some kind of grit must be provided.

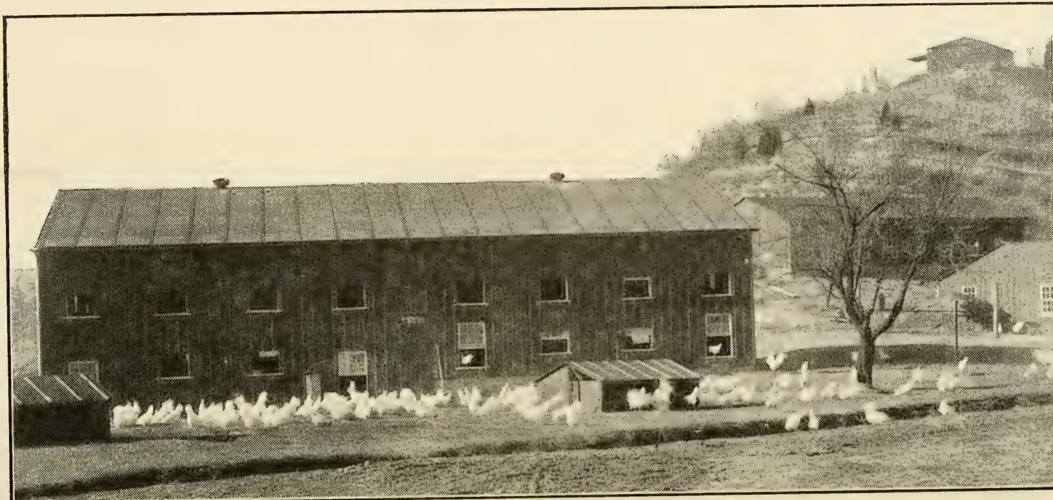



FEED HOPPER

For grain, grit, shell, charcoal, etc., this is a popular pattern.

Besides ordinary grit, it is desirable to supply other material for making the egg shell. Grain does not contain sufficient lime for great egg layers. Oyster and other sea shells are largely used for this purpose, since they are very readily dissolved in the gizzard. Lack of lime or other shell material in the ration often leads to the egg-eating habit among hens. Charcoal is useful as a bowel regulator. The most successful poultrymen keep it constantly before the hens. Salt in moderation aids digestion. An ounce or two daily is sufficient for 100 hens.

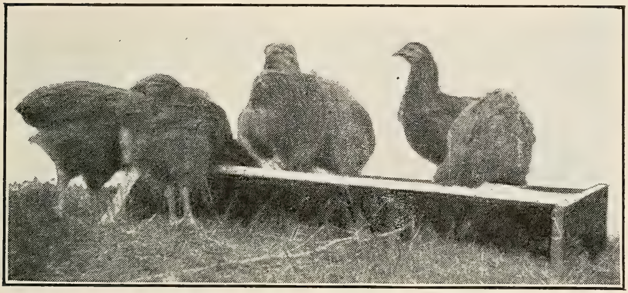
**Hens in Summer.**—If the hens have the run of the



FEED AND WORK HOUSE OF LARGE POULTRY FARM

In this building the grains, grit, charcoal, etc., are stored, mixed and weighed for the various poultry houses scattered over the place so the flocks may not be so large as to be unwieldy and so they may have abundant range on clover and grass. A mash of mixed ground grains is kept in covered hoppers in the fields where the fowls can get it at will. Thus the hens balance their own rations, part of which they get themselves from the forage. Considerable animal food is collected where the range is extensive and where the fowls are not too numerous.

farm, the problem of feeding is simple. In pasture fields and meadows they will secure insects, seeds and grass, supplying in this way what they need for maintenance and eggs. Some grain, however, should be fed daily. This may be a variety, or one or more common grains like corn, wheat, sorghum or millet. A mash feed two or three times a week, with salt added, is greatly relished. If skim milk or buttermilk is available, let it be kept before the



Open Feed Trough for Fowls at Range

The ordinary V-shaped trough is popular especially for feeding wet mashes. Objection to it is that the fowls soil it easily.

fowls, but see that the vessels are clean and sweet. A few drops of carbolic acid or any of the coal tar dips in the milk and water will assist in keeping things pure and wholesome.

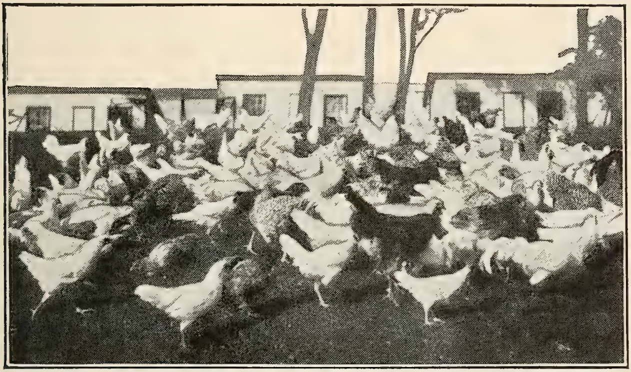
**During the Molt.**—One of the most critical periods in the life of the hen is during the molting period. At this time nutritious and wholesome foods are advisable—those rich in protein—in order that a supply of substances may be at hand for the new feathers. Wheat, oats, peas and sunflower are

all excellent. Some oil meal in the mash, with bran, should be fed daily. Many poultrymen who feed cracklings at this period hold that these and oil meal are two indispensable food products for success with hens during the molting season.

While good layers usually lay more or less during the early stages of the molt, they usually stop when the new feathers are forming rapidly. Attempts have been made to hasten molting, and success has been obtained, but the advantages have not been particularly manifest. If the hens are starved for a period and then heavily fed, the shedding of the old feathers and starting of the new will be apparent; but little effect seems to follow in way of increased egg production. The best way seems to be in heavy feeding; in providing an abundance of food of the nature that builds flesh, feathers and eggs.

**Feeding for Eggs in Winter.**—The reason that the hens do not lay in winter, is not because they are underfed, but because they are too fat. Hens are like other animals. Feed them abundantly, put them under conditions where exercise is not taken and they will become fat and lazy. Moreover, the ovules of the hen become inactive and egg production is an impossibility. It is this way: During the summer and the fall months the hens range in all directions over the farm in search of food, appetizing grasses, tender insects and juicy berries of field and fence corners. This exercise on the fields puts them in excellent health and vigor. Then the farm crops are harvested and gathered. On most farms corn is

gathered and stored; and in most instances it is cribbed where the hens can get at it. They greedily eat of this appetizing grain, and, easily obtainable, they forget their summer habits of thrift and search, and now seek the corn cribs for their daily supply. The result is inevitable; they get fat and quit laying. So long as corn remains they continue in their gluttoning and also fail to lay. Once in this condi-



MIXED FLOCK EATING GRAIN

Especially in winter the evening meal usually consists of grain, because it requires longer to digest than mash. Thus the fowls are believed to be more comfortable during the night than when their stomachs become empty.

tion their usefulness as layers has passed, and the sooner they are eaten or sent to market the better.

The average farmer needs to correct this error in order to put things in the way for more eggs during winter. This, however, will not suffice. Green food, a variety of grains, and meat scraps are needed to supply the egg-producing materials, that the hens may do their best. See that the hens take exercise

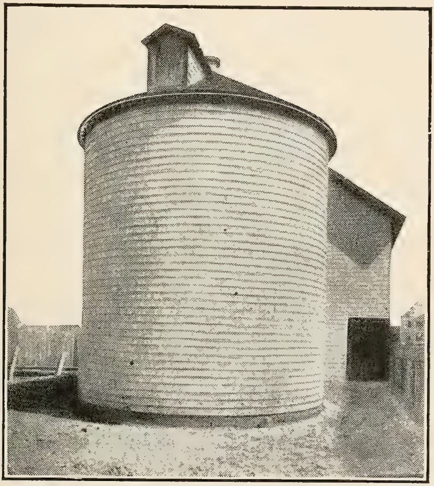
during winter. Provide a scratching pen. Keep this in a deep litter of cut or fine straw, both dry and clean, and scatter the grains in it. The hens will have to work to eat; and by thus exercising, they will not grow fat; and if not fat but active and vigorous, they will naturally lay eggs.

**Tried Ration for Laying Hens.**—The Cornell station has tested many combinations in search of the best grain mixtures for the winter production of eggs. As a result of these feeding tests the following ration has been suggested: For grain, mix 100 pounds of wheat, 100 pounds of cracked corn and 50 pounds of oats and feed in deep litter sparingly in the morning and freely at night. Mash fed in the afternoon in hoppers consists of the following: 60 pounds of wheat middlings, 60 pounds of corn meal, 50 pounds of beef scrap, 30 pounds of wheat bran, 10 pounds of alfalfa meal, 10 pounds of linseed oil meal and a half pound of salt.

## CHAPTER XXII

# THE SILO AND SILAGE

The silo does for live stock what fruit cans and fruit jars do for man. We know that a tomato will quickly decay if not put in the fruit jar where it can be sealed so as to prevent the entrance of bacteria.



NEAT SILO FOR LONG SERVICE

The silo is a large pit that holds cut-up corn or other forage, keeps it succulent and prevents the maturity of the plant cells.

The object of the silo is to keep the forage as near the green state as possible. To this fact is due the noted value of silage. As we, during winter, would

rather eat an apple that has been stored away in the cellar than a dried one, so live stock relish, in the same degree, the corn plant if kept as nearly in the green state as possible. No matter how nutritious a feeding stuff may be, if the animal does not like it, it usually is a failure as a milk or a meat producer. Of course, no one claims that silage contains greater feeding value than the cured product. A silo has nothing about it to make more protein or carbohydrates or fat. But it retains the juice, the flavor, and also the effect of freshness and greenness in the silage properly stored in it.

**Economy in Silage.**—There is a great economy in silage, in the fact that a larger part of the product is eaten than if the green stuff were dried for fodder. If the dry corn plant is fed, the ear and the leaves are the only parts consumed. Fully half the feeding value is lost. If, however, this be put in the silo, every particle is eaten. The feeding value is really doubled. The silo, then, assists the feeder in taking care of a larger number of animals from a given area than otherwise would be possible if only the dry product were fed.

Another point in economy lies in the storage of the feeding stuff. A silo is cheaply constructed and holds an immense quantity of forage that is always at hand where feeding is to be done. Thus the labor for winter feeding is materially lessened. Wherever high-class beef animals are raised or profitable dairying carried on, there the silo is found and its highest and best uses employed.

**Capacity of Silos.**—The following table, by King,

gives the capacity of round silos at various depths and with varying inside diameters:

| Feet depth | Inside diameter in feet | | | |
|---|---|---|---|---|
| | 15 | 18 | 20 | 25 |
| | Tons | Tons | Tons | Tons |
| 20 | 58.8 | 84.7 | 104.6 | 163.4 |
| 21 | 62.9 | 90.6 | 111.8 | 174.7 |
| 22 | 67.4 | 96.8 | 119.6 | 186.8 |
| 23 | 71.7 | 103.3 | 127.5 | 199.3 |
| 24 | 76.1 | 109.6 | 135.3 | 211.5 |
| 25 | 80.6 | 116.1 | 143.3 | 223.9 |
| 26 | 85.5 | 123.0 | 151.9 | 237.4 |
| 27 | 90.2 | 129.8 | 159.3 | 250.5 |
| 28 | 95.0 | 136.8 | 168.9 | 263.9 |
| 29 | 99.9 | 143.9 | 177.6 | 277.6 |
| 30 | 105.0 | 151.1 | 186.6 | 291.6 |
| 31 | 109.8 | 158.2 | 195.6 | 305.1 |
| 32 | 115.1 | 165.7 | 204.6 | 319.6 |

**Corn the Best Silage Crop.**—Silage is pre-eminently adapted to dairy cows, and is frequently used for sheep and other farm animals. In planning a silo, figure on removing at least 1½ inches of the silage surface each day in order to prevent loss from spoiling. From 30 to 40 pounds of silage a day, combined with hay and grain, is considered by most dairymen as a satisfactory ration for dairy cows.

**Essentials of a Good Silo.**—First, it must be made deep in order that the silage may pack down solidly. There should be a depth of at least 24 feet. Satisfactory silos, however, may be built with a depth of only 20 feet, or even less. Second, the walls should be made vertical and perfectly smooth, so the silage may rest evenly on all sides.

There should be as few corners as possible, since

the greatest loss occurs from spoiling in corners. Third, square, wooden silos should have the corners boarded across, and the inside sheathing should run perpendicular at the bottom. Fourth, the inside walls of stone, brick or cement silos should have a final dressing of portland cement. Fifth, the silo should be located where it will be most convenient to feed from.

HARVESTING THE SILAGE CORN

Following the corn harvester come the wagons to haul the green corn to the cutters.

**Calculating Size of Silo.**—The size of the silo to build may be determined in any particular case from the following data: A cubic foot of well-packed silage will weigh on the average between 35 and 40 pounds. This is about the amount that should be fed daily to a dairy cow. If it is necessary to feed cows for six months, 180 days, one cow will consume 180 cubic feet, or about 3½ tons of silage. A herd of 10 cows would consume 35 tons. However, there is always some loss by spoiling and waste, so it is better to figure on about 40 tons.

One acre of corn should yield 10 to 15 tons of silage. The number of tons of silage that a square or a rectangular silo will hold may be determined roughly by multiplying the length, width and depth of the silo in feet, and dividing by 50, the approximate number of cubic feet in a ton of silage. A round silo 15 feet in diameter and 20 feet deep will hold about 60 tons. The same silo 25 feet deep will hold 80 tons. A round silo 20 feet in diameter and 25 feet deep will hold a little more than 140 tons.

**Filling the Silo.**—Nowadays the corn binder is desirable for cutting silage corn. It saves the expense of several men and makes loading and unloading more economical and less fatiguing and irksome than the old method. One man with a low wagon and a rack can in a few minutes secure his load, all that a two or a three-horse team can draw. It is most convenient to take two or three rows at a time. It is necessary, therefore, that the binder be at work for some time in order that the hauling and the cutting crews may not be delayed for want of corn.

The work in the silo, however, is the most important of all operations connected with silage making. Really good silage depends largely upon the faithfulness, constant tramping and the "everlastingly at it" of the man in the silo. Let him shirk, or do his work poorly, and he will get less corn in the silo and poorer quality in the product. Many of the criticisms directed against the silo belong, not to it, but to the man within. He was either lazy and irresponsible, did not know what was expected of him or how to do what was required of him.

This part of silage making is of such great importance that it is necessary to give it close attention. Thoroughly and continually to pack the silage as fast as it falls into the silo and to pitch and tramp it all about the outer edges is the secret of making good silage. Look after the packing well at the outside, and the center will take care of itself. It is this thorough packing that rids the silo of air spaces around which decay later is found to have taken place.

It is more difficult to pack the square than the round silo. Hence the least carelessness here represents some loss in winter. In doing effective packing, keep the outer edges a little higher than the center, but keep tramping and packing all the time. This will force the air out as the filling process goes on.

**Feeding Silage.**—The quantity of silage fed depends somewhat on the kind of forage used. Silage made of clover, cowpeas or alfalfa contains more protein than that made of corn. If either of the former be used, from 15 to 20 pounds will be sufficient for a daily feed. On the other hand, if corn is used, from 25 to 50 pounds can be fed, 30 to 40 pounds being a good average. Silage can be fed once or twice each day. If a small quantity is used in the daily ration, the feeder should give silage but once; a larger quantity will require two feedings. The feeding should be regular; that is, every day, so as to keep the top of the silo fed off to prevent spoiling. One or 2 inches from the whole of the top will prevent any decay.

**Feeding Silage After Milking.**—Silage should not be fed during milking, but always afterward. When

the cows have finished eating, the silage that remains should be cleaned up and removed from the barn. This will prevent the possibility of having silage decay in the mangers. The present objection to silage milk, as it is termed, comes from the slovenliness of those who permit the silage to remain in the barn and decay. If cleanliness is observed, and the silage has been taken care of properly, the milk will be free from the silage taint. The odor of silage put up when the ears are in milk is much stronger than that of silage put up just after the ear has glazed and hardened.

**Crops for Silage.**—There are only a few crops that can be successfully used for silage. The great silo crop is corn. Clover is also ensiled with a fair degree of success. Soy beans mixed with corn are also good, and alfalfa to some extent. Plants which have hollow stems generally make poor silage because of the air stored with the crop. There is also little reason for using crops that are easily cured in the field, like the grasses and hays.

DIGESTIBLE NUTRIENTS IN IMPORTANT SILAGE CROPS

| Feeding stuff | Dry matter in 100 pounds | Digestible nutrients in 100 pounds | | |
|---|---|---|---|---|
| | | Protein | Carbohydrates | Fat |
| Corn silage .. | 20.9 | 0.9 | 11.3 | 0.7 |
| Clover ....... | 28.0 | 2.0 | 13.5 | 1.0 |
| Alfalfa ... | 27.5 | 3.0 | 8.5 | 1.9 |
| Cowpea ...... | 20.7 | 1.5 | 8.6 | 0.9 |
| Soy bean ..... | 25.8 | 2.7 | 8.7 | 1.3 |

**Cutting Corn for Silage.**—The composition of corn undergoes rapid changes from the tasseling period until maturity. The dry matter shows an increase from the time the corn is in tassel until the kernels are dented. Tasseled corn has only one-fifth as much dry matter as mature corn. It is owing to such changes that corn must be cut at the proper stage if it is to make the best silage. If cut too green, the silage will sour more easily, and will not possess the fullest food value. Immature corn is often the cause of the complaints that silage makes undesirable milk. If cut too ripe, the desired succulence is lost. The proper stage for cutting is when the lower leaves have commenced to fire and brown, yet when the greater part of the leaves are still green. The kernels should be out of the milk stage and dented and hardened.

**Cost of Making Silage.**—The following figures as to cost of making silage have been set forth by the Nebraska station:

COST OF GROWING

| | |
|---|---|
| Rent of land | $4.50 |
| Plowing and harrowing | 2.00 |
| Seed corn | 0.25 |
| Planting | 0.30 |
| Harrowing and cultivating | 2.25 |
| Total per acre | $9.30 |
| Average yield, tons an acre | $13.00 |
| Cost per ton to grow | 0.72 |

COST OF FILLING SILO

| | |
|---|---|
| Eleven men at $2 a day | $22.00 |
| Seven teams at $2.25 a day | 16.75 |
| One traction engine a day | 7.50 |
| Engineer | 2.50 |
| Coal | 3.00 |
| Board for men | 6.00 |
| Total | $56.75 |
| Silage cut per day, 75 tons; cost to put in silo per ton | $0.75 |

INTEREST AND DEPRECIATION

| | |
|---|---|
| Interest on money invested in silo | $25.00 |
| Interest on money invested in machinery | 12.00 |
| Depreciation and repairs on silo and machinery per year | 30.00 |
| Taxes and insurance | 6.00 |
| Interest and depreciation per ton | 0.48 |

SUMMARY PER TON

| | |
|---|---|
| Cost of growing | $0.72 |
| Cost of putting in silo | 0.75 |
| Interest and depreciation | 0.48 |
| Total cost of corn silage per ton | $1.95 |

## BUILDING THE SILO

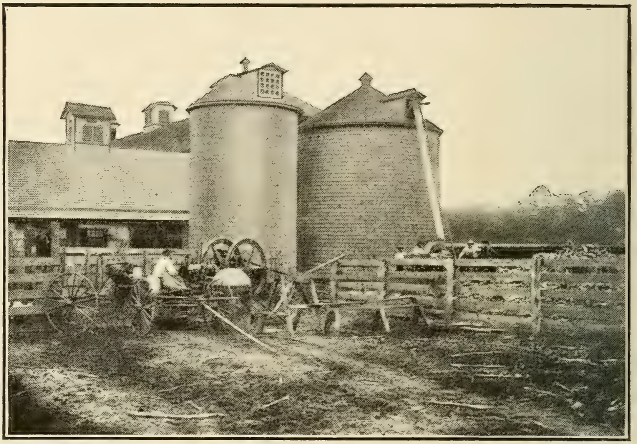
**Many Kinds of Material** are available for construction, but more silos are built of wooden staves than of anything else. Wooden stave silos have the advantage of lower first cost, of being easily and quickly erected by the ordinary help available and of being taken down and moved if necessary.

The round silo is practically the only style now erected, and is generally put up outside the barn, although in round barns it may well be built in the center. After much experimenting farmers and silo manufacturers have almost unanimously settled on the use of staves 2 x 6 inches in size, tongued, grooved and planed on one or both sides. If properly taken care of the wooden stave silo, built of good material, will last a great many years. Should a weak stave develop, it is not a difficult or an expensive matter to replace it.

**Get a Solid Foundation.**—The success of any silo depends on a firm, solid foundation. For this purpose, concrete or concrete and stone are commonly used. The foundation needs to be so well built that it will neither crack nor settle. The silo also needs

a roof which will help to strengthen it and to protect the contents from storm and frost.

Whether or not a man should get out his own material for a silo and build it for himself, or buy it of a silo manufacturer depends upon how good a mechanic he is. A man who is not handy with tools will find it cheaper and better to buy a ready-made



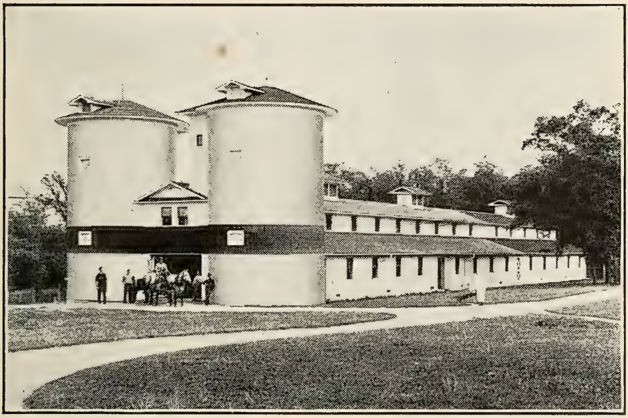
FILLING THE SILO

Corn should be well matured before placed in the silo. With this should go thorough tramping. The silage will then be sweet, substantial and nutritious.

silo, for he will then have one that is built in a scientific manner of good material. The work of erecting a wooden stave silo is not difficult if a good carpenter with a little ingenuity be employed.

**Other Types of Silos.**—Concrete has been used to some extent for silo building, either in the form of blocks or to make solid monolithic walls. Concrete

silos cost more than stave silos, but are virtually indestructible if built of good material under competent supervision, and well reinforced. Many failures come from neglect of one or more of these points. Then the loss is practically total, as it is very difficult to repair a cracked or a broken concrete structure.



CONCRETE SILOS

These are more costly than those made of wooden staves, but they practically last forever.

Brick has been used to some extent for silos, and with good success. Expert help is needed to erect them. Unless brick can be obtained at a low price, their cost is almost prohibitive. The first brick silos were put up of several thicknesses of brick, in some cases the walls being 20 inches thick, but of late years two courses of brick, well reinforced, have been found sufficient.

**Hollow Clay Blocks.**—The latest development consists of the use of hollow clay building blocks. These are easily erected by an expert mason, and are successful if properly reinforced by wire between the various courses of tile. Being built of hollow tile, there is less freezing of the silage on the inside than where the walls are made of brick or solid concrete. The freezing, however, is generally of little importance.

Not every farmer needs a silo, but every farmer who keeps a herd of six or more cows, dairy or beef, or 50 sheep, will find the silo a profitable addition to his farm equipment. More feed can be obtained from an acre of corn saved in the silo than in any other way. It is possible to make more and cheaper milk, beef and mutton by feeding silage than without it.

## CHAPTER XXIII

# THE SOILING SYSTEM

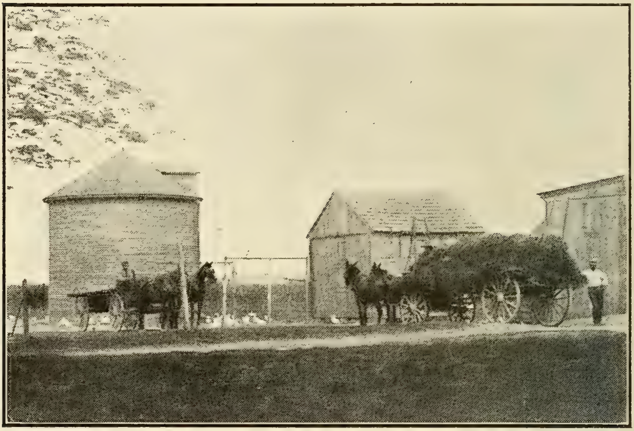
Farm animals relish succulent feeds. They give the best account of themselves when abundantly supplied with pastures or roots or green crops. This is true, not only of cattle, but of hogs, sheep, swine and poultry. Animal life has been so long adjusted to succulence and vegetable juices that to withhold these for any length of time is to invite loss along all lines of production; animals do not thrive well when these are withheld.

When spring comes with its rejuvenating influences manifested in all directions, farm stock eagerly leave dry foods, however rich in nutrition they may be, and revel in the green grasses along the roadside or in the pasture field. You are familiar with the result—better quality, more thrifty growth, more meat, more milk.

Taking the year all around, good pastures are not available for any great length of time; hence, where well-bred farm animals are appreciated, an important problem in farm management arises as to the best method of extending the pasture season as long as possible. Succulent foods may be provided by pasture, soiling crops, silage and root crops. They may be just a bit inferior to May and June grazing, but as substitutes they satisfactorily fill the bill. Good silage, after all, is but slightly inferior to green

corn. Soiling crops are next best to grasses; and roots, for fall and winter, are not to be despised.

**Good Pastures Always Popular.**—The testimony of dairymen is undeniably and emphatically in favor of silage, soiling crops and similar feeds to take the place of pasture, because they keep the milk yield constant. Some even claim that these feeds are in every way equal to rich pastures. Where lands are high in value and limited in quantity, soil-



HAULING SOILING CROPS TO THE BARN

Where the soiling system is followed cows are fed in their stalls. Less land is needed and no forage is destroyed by tramping. The labor on the other hand is increased.

ing crops often displace the pasture system. Some who follow the practice claim that it is even more satisfactory and far less costly. Roots, even for the dairy, but especially for all breeding stock, are indispensable. Horses without carrots, sheep without turnips, Hamlet without the ghost!

Pastures will, no doubt, long remain important in all sections where live stock are grown. Though it is true that the pasture system calls for at least twice the number of acres that are necessary where the soiling system is followed, it must be remembered that with pastures, less labor is required, less attention is needed for looking after the stock, and the items of detail, incidental to soiling, do not arise.

For these reasons permanent pastures are to be desired; in fact, they should be increased and made better. Where lands are exceptionally high in value, the reason for the soiling system becomes manifest at once; but where lands are cheap, there is no reason why the pasture should not be employed in the cheap production of pork or beef, or why it should not enter very largely into the production of dairy products.

Good permanent pastures are worthy of more attention than they have received. If they have not done their work well, it is because their owners have given them too little attention. To merit praise they must give much grazing and constant grazing. The temporary pasture occurs only as a feature of short rotations, as when grain crops are raised. It is really an incident rather than a first consideration; being such, development of grass and turf, both of which are basic features of the permanent pasture, is not expected.

**Rape Supplements Pastures.**—On the other hand, poor pasture fields may be supported by the use of supplementary crops, foremost among which is rape —an admirable food for sheep and swine and val-

uable for cattle also. Rape is a sort of cabbage, which, instead of storing its nutriment in the head as the cabbage does, distributes its nutriment throughout the leaves. It fancies most the moist, cool places and a rather fertile soil. When so favored it really gives a very large amount of food. It is sufficiently rich in nutriment to maintain all body needs, but is not quite able of itself to make large gains of growth or fat. When supplemented with grain, it becomes a very satisfactory green fodder crop.

WHEAT A GOOD SOILING CROP

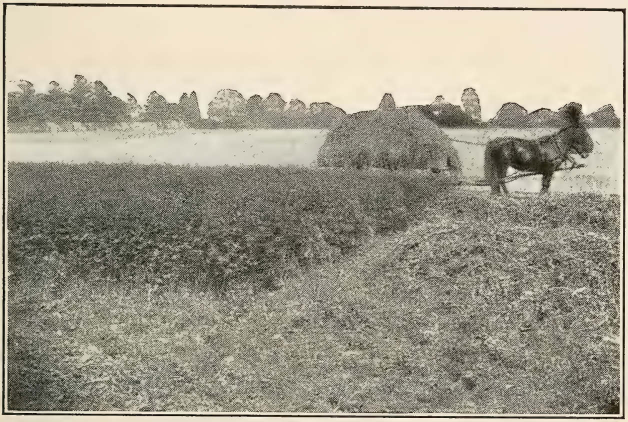
The plot at the left made 4.6 tons to the acre. The plot at the right had been given an application of nitrate of soda and produced 7½ tons to the acre.

Rape may be sown any time between March and July, either broadcast or in drills 3 feet apart, using three or four pounds of slightly covered seed an acre. When grazed down, remove the stock and allow time enough for a second crop.

**Soiling Crops in Favor.**—Within recent years the use of soiling crops has increased. The unsatisfactory results from pastures during the late summer

months, especially for dairy cows, have given popularity to the soiling system. Employed in connection with the silo, it is possible to get the effect of green crops throughout the year.

Briefly, the plan means that instead of depending upon pastures, fodder is cut green and fed to cattle



ALFALFA THE BEST SOILING CROP

From early spring until frost this queen of the crops is available for all kinds of feed.

in the feed lot or in the stable, thus doing away with fences and extensive areas, such as are necessary with pastures. There is a saving, because no part of the forage is tramped on or destroyed by animals running at large over the fields. The small area given to soiling crops allows more intensive tillage, better fertilizing and more thorough cultivation than does the pasture system. The soiling system is favored because it is extremely valuable,

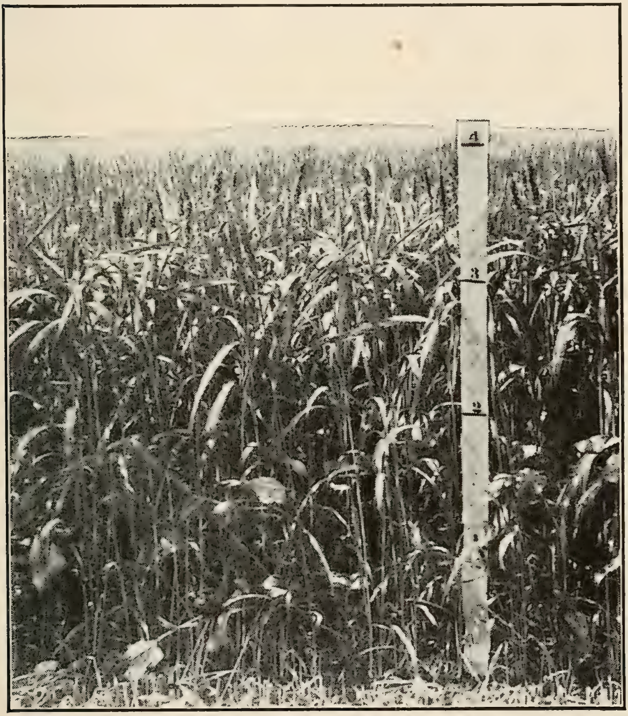
even where pastures are much in use. Rye, peas, oats, and green corn always come in handy; and they often bridge over dry periods when pastures are either short or are dry and withered.

**Soiling Crops Have a Place.**—Starting with soiling crops in order of their use, we have rye as the first aid. In the South it is ready in March and in the North in April. It should be seeded in August or September in the North, and in September or October in the South. When thus planted it is ready early in the spring, long before ordinary pastures are available, or before clover or wheat can be used.

**Alfalfa Ranks First.**—Alfalfa is the premier soiling crop. After alfalfa come peas, sorghum, corn and other green crops. The oats and peas should go in early. Cover the peas 3 or 4 inches deep, one bushel to the acre; the oats a less depth and about two bushels to the acre. Inasmuch as oats fancy the cool seasons rather than the warm weather, the earlier they are seeded in the spring, the better. Field peas also withstand a surprisingly large amount of cold weather. Cowpeas and sorghum are warm weather crops, and should go in after corn.

**Green Corn for Summer.**—Corn is an all-farm-purpose crop. It is advisable to have a couple or more acres of corn as a reserve crop for late summer feeding. Every animal on the farm relishes a few stalks of green corn at night or morning when the pastures are dry and hot. The soil for soiling corn should be light and warm to insure early planting. After being well tilled and fertilized, put in the corn. Plant in rows 3½ to 4 feet apart, dropping

grains 3 or 4 inches apart in the rows. Give this corn the same cultivation and care as later you will give to your regular crop. In any section, by the



BARNYARD MILLET A HEAVY YIELDER

The millets are all good forage crops, but Japanese barnyard millet is an exceptionally profitable variety. The yield here is 15 tons to the acre.

latter part of June or early in July you will have on hand a lot of green forage to help along in case your pastures go back on you.

If this green fodder is not needed in early summer, just let it alone; it will continue its growing and will make a still heavier crop. With it at hand you need have no fear of a shrinkage in milk, because a few armfuls of this green corn as a feed, used as a supplement to the pasture or the silage or other food, will complete the ration and supply your stock with just what is needed. The patch of corn, its size depending upon the number of animals you have, will carry you until the silage crop is ready, or if you do not have the silo, carry you into the fall season, when your winter plans for feeding will handle the case.

**Root Crops Not to Be Left Out.**—Roots receive too little attention by farmers, but they are worthy of some attention, for they stand high as succulent and supplementary feeds. Roots cannot be valued solely by the nutriment they contain. They aid in digestion and assimilation of dry foods and contribute to the healthfulness of all animals so fortunate as to get them. If fruits are of value, if not a necessity, to men, then roots and grasses have a place in feeding farm animals.

Carrots may be fed to horses and sheep, sugar beets and turnips to dry cattle, lambs and dairy cattle; all three are relished by hogs. To withhold succulence, Nature's great provision of thrift and health, is to lessen profits. Ask the men who use these crops; the horse breeder where carrots are known; the shepherd who knows his sheep and succeeds with them; the cattle breeder who has learned of the value of roots for health and appetite. The

testimony as given is generally in favor of roots or of succulent substitutes.

## ADVANTAGES OF SOILING

**Smaller Area Needed.**—Where pasturing is followed, from two to five acres are required for furnishing necessary feeding stuffs for each animal a

Crop of Cowpeas and Kafir Corn

This combination makes a splendid soiling crop. The yield in this instance was 13 tons to the acre.

year. It is generally conceded by all who have followed soiling that three-quarters to an acre and a half will furnish the yearly food supply for a mature animal.

**Fewer Fences Needed.**—The only fences needed with soiling are for the feed lots. This is a saving of land where fences would be put, a saving of capital otherwise invested in fences, and a saving in labor in keeping fences clean and repaired.

**Food Destroyed by Tramping.**—The tramping of cattle over pasture lands not only destroys considerable food, but it compacts the soil, especially during wet weather, and greatly damages the physical condition of the soil. As much as a third or a half of the pastures are injured by tramping.

**Less Acreage Required.**—If one lives near a city where lands are highly valuable, the investment in acres is a matter of considerable importance. The practice of soiling enables the dairyman to do on half the number of acres what would be required if pasturing were followed.

**Soil Improvement More Readily Obtained.**—Since one needs but half the area by following soiling methods that pasture systems require, a larger quantity of manure may be secured by this system. This means farming in an intensive way and insures greater productivity of land and larger crops with each successive year.

## OBJECTIONS TO THE PRACTICE OF SOILING

The one objection to soiling is in the extra labor in growing and feeding the crops. By pasturing, labor is needed only in taking cattle to and from the pasture fields. The necessary extra labor connected with the soiling system is, however, a matter of small importance when considered in the light of the many advantages.

**Soiling Best Adapted to Dairying.**—While soiling is possible for all classes of live stock, it is pecul-

iarly a system for the dairy farmer. The food is better because of freshness and succulence; labor is always available; and the greater profits permit greater care and attention that the highest success may be attained.

Crimson Clover for Soiling

This admirable crop is a great soil improver and winter cover crop. It matures early in the spring and may be pastured, cut for hay, or fed green in the stable.

## SUGGESTIONS FOR A SOILING SCHEME

Among the best soiling crops the following may be mentioned: Peas and oats, rye, alfalfa, clover, vetch and wheat, soy beans, cowpeas, corn, millet, sorghum, and rape. On some farms green crops are fed throughout the season. In a general way the practice includes the rotation somewhat as follows,

with substitutes in certain cases where the season has unfavorably influenced the usual order or makes possible the use of some local crop:

a. Winter rye, or wheat, to be cut in May.

b. Green alfalfa, to be used at any time.

c. Green clover, cut and fed in June.

d. Peas and oats, sown early in spring, with a succession at two or three intervals.

e. Corn or sorghum, planted as early as possible, to be used during July and August.

f. Millet, planted in June or early July and fed in August.

g. The land from which the peas and oats and early corn are removed may be seeded to millet for August feeding.

**Some Special Rotations.**—Following are given several rotations that have been in use in various sections:

LINDSEY'S PLAN FOR NORTHERN NEW ENGLAND

| Kind | Seed per acre | Time of seeding | Area for 10 cows | Time of cutting |
|---|---|---|---|---|
| Rye | 2 bu. | Sept. 10 to 15 | ½ acre | May 20 to May 30 |
| Wheat | 2 bu. | Sept. 10 to 15 | ½ acre | June 1 to June 15 |
| Red clover | 20 lbs | July 15 to Aug. 1 | ½ acre | June 15 to June 25 |
| Grass and clover | ½ bu. red top<br>1 pk. timothy<br>10 lbs red clover | September | 2-3 acre | June 15 to June 30 |
| Vetch and oats | 3 bu. oats<br>50 lbs vetch | April 20 | ½ acre | June 25 to July 10 |
| Vetch and oats | 3 bu. oats<br>50 lbs vetch | April 30 | ½ acre | July 10 to July 20 |
| Peas and oats | 1½ bu. Canada peas<br>1½ bu. oats | April 20 | ½ acre | June 25 to July 10 |
| Peas and oats | 1½ bu. Canada peas<br>1½ bu. oats | April 30 | ½ acre | July 10 to July 20 |
| Barnyard millet | 1 pk. | May 10 | 1-3 acre | July 25 to Aug. 10 |
| Barnyard millet | 1 pk. | May 25 | 1-3 acre | Aug. 10 to Aug. 20 |
| Soy beans, medium, green | 18 qts. | May 20 | 1-3 acre | Aug. 25 to Sept. 15 |
| Corn | ——— | May 20 | 1-3 acre | Aug. 25 to Sept. 10 |
| Corn | ——— | May 30 | 1-3 acre | Sept. 10 to Sept. 20 |
| Hungarian | 1 bu. | July 15 | ½ acre | Sept. 20 to Sept. 30 |
| Barley and peas | 1½ bu. peas<br>1½ bu. barley | August 5 | 1 acre | Oct. 1 to Oct. 20 |

PHELPS'S PLAN FOR SOUTHERN AND WESTERN NEW ENGLAND

| Kind of fodder | Amount of seed per acre | Approximate time of seeding | Approximate time of feeding |
|---|---|---|---|
| 1. Rye fodder | 2½ to 3 bu. | Sept. 1 | May 10-20 |
| 2. Wheat fodder | 2½ to 3 bu. | Sept. 5-10 | May 20-June 5 |
| 3. Clover | 20 lb. | July 20-30 | June 5-15 |
| 4. Grass (from grass lands) | | | June 15-25 |
| 5. Oats and peas | 2 bu. each | April 10 | June 25-July 10 |
| 6. Oats and peas | 2 bu. each | April 20 | July 10-20 |
| 7. Oats and peas | 2 bu. each | April 30 | July 20-Aug. 1 |
| 8. Hungarian | 1½ bu. | June 1 | Aug. 1-10 |
| 9. Clover rowen (from 3) | | | Aug. 10-20 |
| 10. Soy beans | 1 bu. | May 25 | Aug. 20-Sept. 5 |
| 11. Cowpeas | 1 bu. | June 5-10 | Sept. 5-20 |
| 12. Rowen grass (from grass lands) | | | Sept. 20-30 |
| 13. Barley and peas | 2 bu. each | Aug. 5-10 | Oct. 1-30 |

WATSON AND MAIRS'S ROTATION FOR PENNSYLVANIA

| Crop | Area for 10 cows | When to be fed |
|---|---|---|
| Rye | ½ acre | May 15-June 1 |
| Alfalfa | 2 acres | June 1-June 12 |
| Clover and timothy | ¾ acre | June 12-June 24 |
| Peas and oats | 1 acre | June 24-July 15 |
| Alfalfa (second crop) | 2 acres | July 15-Aug. 11 |
| Sorghum and cowpeas (after rye) | ½ acre | Aug 11-Aug. 28 |
| Cowpeas (after peas and oats) | 1 acre | Aug. 28-Sept. 30 |

PARTIAL SOILING FOR ILLINOIS (FRAZER)

| Kind of fodder | Amount of seed per acre | Approximate time of seeding | Approximate time of feeding |
|---|---|---|---|
| 1. Corn (early, sweet or dent) | 6 qts. | May 1 | July 1-Aug. 1 |
| 2. Corn (medium, dent) | 5 qts. | May 15 | Aug. 1-Sept. 30 |
| 3. Cowpeas | 1 bu. | May 15 | Aug. 1-Sept. 15 |
| 4. Soy beans | 1 bu. | May 15 | Aug. 1-Sept. 15 |
| 5. Oats and Canada peas | 1 bu. each | April 15 | July 1-July 15 |
| 6. Oats and Canada peas | 1 bu. each | May 1 | July 15-Aug. 1 |
| 7. Rape | 4 lbs. | May 1 | July 1-Aug. 1 |
| 8. Rape (second sowing) | 4 lbs. | June 1 | Aug. 1-Sept. 1 |
| 9. Rape (third sowing) | 4 lbs. | July 1 | Sept. 1-Oct. 1 |

CARLYLE'S SCHEME FOR WISCONSIN

| Crop | Pounds of seed per acre | Time for sowing | Time of cutting | Acreage for 10 cows | Degrees of maturity |
|---|---|---|---|---|---|
| Fall rye | 168 | Sept. 10 | May 15-June 1 | 1-3 | Before blooming |
| Alfalfa | 20 | March 20 | June 1-15 | 1-3 | Before blooming |
| Red clover | 15 | | June 15-25 | 1-3 | In bloom |
| Peas and oats | P-60<br>O-48 | April 16 | June 25-July 5 | 1-6 | In milk |
| Peas and oats | P-60<br>O-48 | April 26 | July 5-15 | 1-6 | In milk |
| Oats | 80 | May 5 | July 15-25 | 1-6 | In milk |
| Alfalfa (second crop) | — | —— | July 15-30 | — | Before blooming |
| Rape | 2.5 | May 26 | Aug. 1-15 | 1-8 | Mature |
| Flint corn | — | May 20 | Aug. 15-25 | 1-8 | In silk |
| Sorghum | 50 | June 1 | Aug. 25-Sept. 10 | 1-10 | When well headed |
| Evergreen, sweet corn | — | May 31 | Sept. 10-25 | 1-8 | In silk |
| Rape | 2.5 | July 20 | Sept. 25-Oct. 10 | 1-8 | Mature |

HUNTER'S PLAN FOR OREGON AND WESTERN WASHINGTON

| Crops | When planted | When used |
|---|---|---|
| Rye and vetch ........................ | Sept. 1-15 | April 1-May 15 |
| Winter oats and vetch .............. | Sept. & Oct. | May 15-July 1 |
| Winter wheat and vetch ............ | Sept. & Oct. | May 15-July 1 |
| Red clover ......................... | —— | May 15-July 1 |
| Alfalfa ............................. | —— | June |
| Oats and peas ..................... | Feb. | June |
| Oats and vetch ..................... | Feb. | June 15-July 15 |
| Oats and peas ..................... | April | July |
| Rape ................................ | May | July |
| Oats and peas ..................... | May | August |
| Rape ................................ | June | August |
| Corn ................................ | May 10-20 | August |
| Turnips ............................ | July | Fall and early winter |
| Thousand-headed kale .............. | March 15 | October to April |
| Mangels, carrots and rutabagas ... | April | Winter |

# CHAPTER XXIV

## RELATION OF FOOD TO MANURE

**Quality of Manure.**—On many farms manure is measured by its quantity rather than by its quality. In open barnyards it is left to accumulate, often for

EITHER TOO MUCH OR TOO LITTLE

When manure is put in small piles it is generally unevenly distributed. If not immediately spread the soluble parts sink into the ground under the piles, thus over-enriching these spots. The greater part of the soil area gets only the manure debris.

a year or more; and exposed to rain and weather it decomposes, and wastes away, or is lost in rich streams of colored liquid to brooks and creeks. When so handled the cream of its value escapes from

the farm, leaving only the debris and coarser parts for the fields and vegetation. The evil of this way of preserving manure more and more is becoming apparent and a change in this respect ought to be more commonly set in motion in the future.

But there is still too little attention given the production of manure from the standpoint of quality. Many farmers give little thought to food in relation to the resulting manure. They seem to think that manure is just manure, and that one kind of food is about as good as another for producing it. When purchasing a feeding stuff its fertilizing value is usually ignored when, in fact, this matter should be weighed as carefully as are the food nutrients contained in it. Take two feeds like corn and cottonseed meal. Both may be and are used extensively in the feeding of cattle. In many tests the latter has shown its superiority both for beef and the dairy. The comparison is incomplete, however, if the fertilizing values are not compared also. This has been done in the following table:

CORN AND COTTONSEED MEAL COMPARED

| Feed | In 1 ton of product | | | Value |
|---|---|---|---|---|
| | Nitrogen | Phosphoric | Potash | |
| Corn .......... | 33.0 | 14.2 | 11.4 | $ 6.56 |
| Cottonseed meal | 145.0 | 60.8 | 31.6 | 27.82 |

From this we see that, allowing 16 cents a pound for nitrogen and 5 cents each for phosphoric acid and potash, the fertilizing value of the cottonseed

meal is $27.82, while of corn it is but $6.56, or one-fourth as much. To the man who is obliged to buy either corn or cottonseed meal this should be conclusive that it is in his interest, both from the standpoint of feed and of manure, to purchase the cottonseed meal.

**Value of Farm Manures.**—The character of the food determines the value of manure. The animal can add nothing. In the undigested portions the fertilizing materials are voided, while of that absorbed into the system, such amounts are appropriated as are needed. In case of animals neither gaining nor losing in weight—for instance, farm horses that just hold their own—as much fertilizer materials are returned in solid and liquid excrement as are taken in the food from day to day. In this case, if the manure is wholly returned to the land, the entire food supply serves as fertilizing material.

Young and growing animals and those furnishing wool or milk, retain considerable amounts of the nitrogen and the ash constituents. Fattening animals that are nearly mature retain but small amounts of nitrogen and ash. These facts are indicated in the table by Warrington given on the next page.

The amount of ash constituents of the food stored up in the body is very small. As seen in the table, fattening oxen retain but 2.3 per cent, fattening sheep 3.8 per cent, and fattening pigs 4 per cent. Milk cows retain more; this is to be found in the milk. The young calf puts into bone and muscles over one-half of the ash of its food. As for nitro-

gen, the work horse, either at rest or at work, gives back all, fattening oxen and sheep retain a small amount, fattening hogs a larger amount, milk cows keep one-fourth, and the young calf two-thirds. Nitrogen is voided largely as urine.

**Double Value in Feeds.**—All feeding stuffs have two values—feed and fertility. The commercial

NITROGEN AND ASH IN ANIMAL PRODUCE, AND VOIDED, FOR 100 POUNDS OF FOOD CONSUMED

| Kind of animal | Nitrogen | | | Ash constituents | | |
|---|---|---|---|---|---|---|
| | Obtained in carcass or milk | Voided in solid excrement | Voided in urine | In total excrement | Obtained in carcass or milk | Voided in excrement and perspiration |
| Horse at rest .... | None | 43.0 | 57.0 | 100.0 | None | 100.0 |
| Horse at work ... | None | 29.4 | 70.6 | 100.0 | — | — |
| Fattening oxen .. | 3.9 | 22.6 | 73.5 | 96.1 | 2.3 | 97.7 |
| Fattening sheep.. | 4.3 | 16.7 | 79.0 | 95.7 | 3.8 | 96.2 |
| Fattening pigs .. | 14.7 | 21.0 | 64.3 | 85.3 | 4.0 | 96.0 |
| Milk cows ...... | 24.5 | 18.1 | 57.41 | 75.5 | 10.3 | 89.7 |
| Calf on milk ..... | 69.3 | 5.1 | 25.6 | 30.7 | 54.3 | 45.7 |

value in most instances is based on the feeding value as compared with other feeding stuffs. But even so, the fertilizing value of manure resulting must be ignored no longer. To illustrate the meaning of the double value of a feed, it is here assumed that cottonseed meal has a commercial value of $27.82. This is the first or fertilizing value; and since by feeding it valuable food products are made, a second value is possessed by it.

It has been observed that milk cows retain 24.5 per cent of the nitrogen of the food. Deducting, therefore, one-fourth of this to meet the cost of the fertilizing materials extracted, there is left $20.87. In other words, as a feed the cost was only $6.95 a ton. When so used a double profit is secured as follows:

| | |
|---|---|
| Value as a fertilizer | $27.82 |
| Value after being fed | 20.87 |
| Total | $48.69 |

**Selling Fertility.**—The man who buys cottonseed meal and other similar feeding stuffs as feed gains by the enterprise, but the men who produce and sell them, lose. By disposing of these valuable food products farmers sell the plant food of their lands. When sent to Europe or to other sections there is transferred fertility from the lands producing these crops to the dairy and beef farms where they are consumed. When animal products are sold the drain on the land is not large, but if grain crops are sold much plant food is withdrawn from the soil. This will be seen in the table on the next page.

This table shows that grain products make considerable demands on the plant food supply of the soil, and that when such are sold much more fertility is disposed of than when animal products are sold.

The farmer who sells a ton of clover hay withdraws from his soil $8.72 worth of fertility. This is half as much as he receives. If, on the other hand, he sells a ton of pork, he sends from his farm but $6.35 worth of fertility, but receives 20 times as

much for it as the value of the fertility contained in it. If he sells milk he receives 40 times as much as the fertility contained in it, and if he sells butter his returns are 1,000 times as much as is the value of the fertility sold in the butter product.

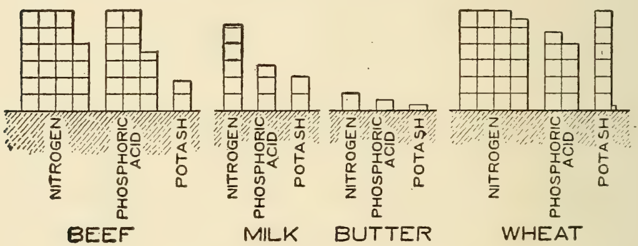
FERTILIZING CONSTITUENTS IN CERTAIN PLANT AND ANIMAL PRODUCTS

| Material | In one ton of substance | | | Value |
|---|---|---|---|---|
| | Nitrogen | Phosphoric acid | Potash | |
| Timothy hay .... | 18.8 | 6.6 | 28.4 | $ 4.75 |
| Clover hay ...... | 39.4 | 11.0 | 37.4 | 8.72 |
| Corn ............ | 33.0 | 14.2 | 11.4 | 6.56 |
| Wheat .......... | 38.0 | 11.0 | 17.4 | 7.50 |
| Cottonseed meal.. | 145.0 | 60.8 | 31.6 | 27.82 |
| Fat ox .......... | 46.6 | 31.0 | 3.8 | 9.19 |
| Fat pig ......... | 35.4 | 13.0 | 2.8 | 6.35 |
| Milk ............ | 11.6 | 3.8 | 3.4 | 2.17 |
| Butter .......... | 2.4 | 0.8 | 0.4 | 0.44 |

**Loss of Fertility Contained in Feed.**—Due to careless methods of handling manure, there is a tremendous loss of fertility in the aggregate each year. Much of the nitrogen is lost through fermentation and leaching as fast as the manure is made. Much of the potash is lost in drainage waters from the stable and the barnyards. This loss can be greatly lessened by the use of litter in the stables, by covered barnyards, and through the addition from day to day of some preservative like acid phosphate to the excrement as made.

There is loss through leaching, not only in barnyards, but wherever manure is exposed to the influ-

ence of the weather. In loose, open piles fully one-half of the fertilizing value may disappear in a half-year period. If manure is not hauled direct to the field and scattered, it may be fairly well preserved in large piles, which should be kept moist; or in covered barnyards, where it should be thoroughly compacted, with enough litter provided to absorb the liquid and keep the animals clean. Fresh manures that undergo fermentation rapidly, such as horse and sheep manures, should be mixed with lit-




REMOVAL OF FERTILITY

In the sketch are shown the amounts of nitrogen, phosphoric acid and potash removed from the soil when 1,000 pounds each of beef, milk, butter and wheat are sold.

ter immediately, else the nitrogen will be lost. Gypsum sprinkled on fresh manure has long been a popular preservative.

**Poor Manure.**—That it pays to give the preservation of manure close attention is shown by the tests conducted by the Ohio station. Here poorly preserved and well-preserved manure was used in field tests. In both cases the rate of application was eight tons to the acre on clover sod plowed under for corn, and then followed in a three-year rotation

with wheat and clover without further manuring or fertilizing. The table following shows the average increase of each crop for both kinds of manure:

YARD AND FRESH MANURE COMPARED

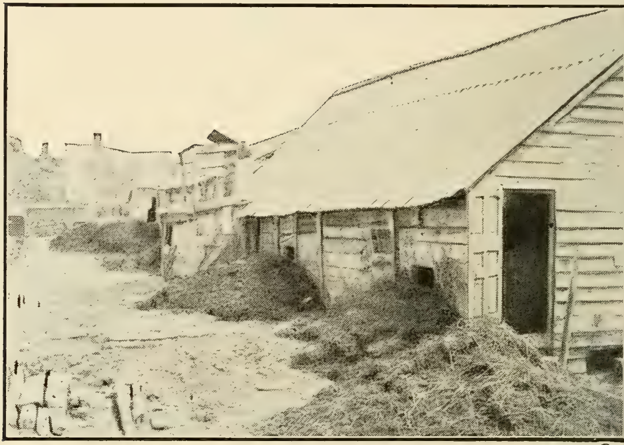
| Kind of manure | Bushels of corn | Bushels of wheat | Pounds of hay |
|---|---|---|---|
| Yard manure ..... | 16.03 | 8.21 | 698 |
| Fresh manure .... | 22.24 | 9.73 | 1,280 |

In discussing these tests, Director Thorne says that not only was the manure greatly reduced in quantity, but the quality likewise was impaired by exposure, the rain leaching out the most soluble and therefore the most valuable portion. At current prices the average increase from a ton of open yard manure, including the straw and stover, was worth about $2, while that from the fresh manure reached an average value of nearly $3, and this value was increased to $4.50 when the manure was reinforced with acid phosphate.

That manure materially decreases in bulk and plant food value is shown in an experiment recorded by Professor Roberts. Starting with 4,000 pounds of manure the amount decreased to 1,730 pounds; because of poor preservation 60 per cent of the nitrogen escaped into the air; and 75 per cent of the potassium and 40 per cent of the phosphorus leached away in rain water. When this pile of manure is considered from the standpoint of money value, it is found that at the beginning it was worth $5.48; but

after being exposed for five months the plant food value was only $2.03—scarcely one-third its original value.

**Why Full Value of Fertility of Feeds Is Not Secured to Lands.**—Many farmers fail to get results in the field from the use of manure, considered from



HOW FARM MANURE IS WASTED

Handled in this manner, the nitrogen and soluble fertilizing materials leach out and waste away. This explains why much farm manure is of little value when placed on the land.

the standpoint of actual fertilizing value, not because the plant food is not in the manure made from the feed given the animals, but because of neglect after the manure has been made. Farmers often fail also to get a full response from the use of feeds, just as they fail to get maximum returns from the manure made from the feeds.

From actual feeding tests it has been shown that a ton of alfalfa or of cowpea hay is almost equal in feeding value to a ton of wheat bran. This is not only evident from the digestible composition of these feeds, but from feeding tests. If, therefore, when put to the test a ton of alfalfa proves far inferior to wheat bran, or if when this alfalfa is fed to beef or dairy cattle the full fertilizing value is not secured; or if gluten, cottonseed meal, or other concentrates, when fed, do not fetch the results in the field when the resulting manure is applied, it should not be concluded that the practical side of the feed and the fertilizing questions do not correspond with the theoretical facts.

Ordinarily, the explanation will be found elsewhere. A ton of inferior alfalfa hay is not equal in feeding value to a ton of wheat bran if weather-beaten, much rained upon, or weedy and unappetizing. A ton of cottonseed meal is not worth its estimated value for feeding and fertilizing if it contains so many hulls that its protein and fat constituents are far below its normal composition. The fact is, the plant food contained in a ton of cottonseed meal is worth $27.82 according to the prices of commercial fertilizers, but the farmer will fail to get results in line with this fact if the liquid manure is lost or if the manure is leached by rains or burned up through fermentation. This same cottonseed meal will not be worth its commercial price as a feeding stuff when fed to a poor cow or steer as compared with other feeds of good quality consumed by a good cow or steer.

**The Full Value of a Feeding Stuff** for feed and fertilizer is secured only when the feed has been properly prepared in the first place, then fed in the proper combination with other feeds to farm animals of good breeding and selected for the purpose to which they are best adapted, and finally so handled as manure that the fertilizing materials are not lost through fermentation, decomposition and leaching. Such practice is good farming and is fundamental for success in feed lot or open field.

# APPENDIX

# APPENDIX

The tables giving the average digestible nutrients and the fertilizing constituents in the following American feeding stuffs have been adapted from Henry's "Feeds and Feeding."

| Name of feed | Total dry matter in 100 lbs | Digestible nutrients in 100 pounds | | | Fertilizing constituents in 1,000 pounds | | |
|---|---|---|---|---|---|---|---|
| | | Crude protein | Carbo-hydrates | Fat | Nitrogen | Phos-phoric acid | Potash |
| Grains, seeds, and their parts | Lbs | Lbs | Lbs | Lbs | Lbs | Lbs | Lbs |
| Dent corn | 89.4 | 7.8 | 66.8 | 4.3 | 16.5 | 7.1 | 5.7 |
| Flint corn | 88.7 | 8.0 | 66.2 | 4.3 | 16.8 | 7.1 | 5.7 |
| Sweet corn | 91.2 | 8.8 | 63.7 | 7.0 | 18.6 | 7.1 | 5.7 |
| Corn meal | 85.0 | 6.1 | 64.3 | 3.5 | 14.7 | 6.3 | 4.7 |
| Corn cob | 89.3 | 0.5 | 44.8 | — | 3.9 | 0.6 | 6.0 |
| Corn-and-cob meal | 84.9 | 4.4 | 60.0 | 2.9 | 13.6 | 5.7 | 4.7 |
| Gluten meal | 90.5 | 29.7 | 42.5 | 6.1 | 54.8 | 3.3 | 0.5 |
| Gluten feed | 90.8 | 21.3 | 52.8 | 2.9 | 40.0 | 3.7 | 0.4 |
| Feed chop | 90.4 | 6.8 | 60.5 | 7.4 | 16.8 | 9.8 | 4.9 |
| Germ oil meal | 91.4 | 15.8 | 38.8 | 10.8 | 34.7 | 3.9 | 2.1 |
| Corn bran | 90.6 | 6.0 | 52.5 | 4.8 | 17.9 | 10.1 | 6.2 |
| Wheat | 89.5 | 8.8 | 67.5 | 1.5 | 19.0 | 5.5 | 8.7 |
| High-grade flour | 87.6 | 10.6 | 65.1 | 1.0 | 19.2 | 5.7 | 5.4 |
| Red dog flour | 90.1 | 16.2 | 57.0 | 3.4 | 29.4 | — | — |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Flour wheat middlings | 90.0 | 16.9 | 53.6 | 4.1 | 30.7 | 12.2 | 9.6 |
| Wheat middlings | 88.8 | 13.0 | 45.7 | 4.5 | 27.0 | 26.3 | 15.3 |
| Wheat bran (all analyses) | 88.1 | 11.9 | 42.0 | 2.5 | 24.6 | 26.9 | 15.2 |
| Wheat feed | 89.1 | 12.7 | 47.1 | 4.0 | 26.1 | 20.4 | 5.4 |
| Wheat screenings | 88.4 | 9.6 | 48.2 | 1.9 | 20.0 | 11.7 | 8.4 |
| Rye | 91.3 | 9.5 | 69.4 | 1.2 | 18.1 | 8.6 | 5.8 |
| Rye flour | 86.9 | 5.6 | 72.2 | 0.5 | 10.7 | 8.2 | 6.5 |
| Rye middlings | 88.2 | 11.0 | 52.9 | 2.6 | 22.9 | 12.3 | 9.6 |
| Rye bran | 88.4 | 11.2 | 46.8 | 1.8 | 23.3 | 22.8 | 14.0 |
| Rye feed | 87.6 | 12.6 | 56.6 | 2.8 | 25.1 | 7.7 | 4.7 |
| Barley | 89.2 | 8.4 | 65.3 | 1.6 | 19.2 | 7.9 | 4.8 |
| Emmer (speltz) | 92.0 | 10.0 | 70.3 | 2.0 | 18.4 | 7.6 | 5.7 |
| Oats | 89.6 | 8.8 | 49.2 | 4.3 | 18.2 | 7.8 | 4.8 |
| Ground oats | 88.0 | 10.1 | 52.5 | 3.7 | 19.7 | 7.6 | 5.0 |
| Oat middlings | 91.2 | 13.1 | 57.7 | 6.5 | 25.9 | 22.5 | 15.3 |
| Oat feed | 93.0 | 5.2 | 30.1 | 2.6 | 12.8 | 6.1 | 7.2 |
| Oat hulls | 92.6 | 1.3 | 38.5 | 0.6 | 5.3 | 1.6 | 4.9 |
| Buckwheat | 86.6 | 8.1 | 48.2 | 2.4 | 17.3 | 6.9 | 3.0 |
| Buckwheat flour | 85.4 | 5.9 | 63.0 | 1.2 | 11.0 | 6.8 | 3.4 |
| Buckwheat middlings | 87.2 | 22.7 | 37.5 | 6.1 | 42.7 | 12.3 | 11.4 |
| Buckwheat bran | 91.8 | 5.9 | 34.0 | 2.0 | 20.2 | 4.2 | 12.7 |
| Buckwheat feed | 88.4 | 15.6 | 38.2 | 4.4 | 29.3 | 15.8 | 10.5 |
| Buckwheat hulls | 86.8 | 1.2 | 28.6 | 0.5 | 7.3 | 4.3 | 14.7 |
| Rice | 87.6 | 6.4 | 79.2 | 0.4 | 11.8 | 1.8 | 0.9 |
| Rice polish | 89.2 | 7.9 | 58.6 | 5.3 | 19.0 | 26.7 | 7.1 |
| Rice bran | 90.3 | 7.6 | 38.8 | 7.3 | 19.0 | 2.9 | 2.4 |
| Rice hulls | 91.2 | 0.3 | 19.9 | 0.7 | 5.1 | 1.7 | 1.4 |
| Canada field pea | 85.0 | 19.7 | 49.3 | 0.4 | 37.9 | 8.4 | 10.1 |
| Canada field pea meal | 89.5 | 16.8 | 51.7 | 0.7 | 32.3 | 8.2 | 9.9 |
| Canada field pea bran | 89.0 | 7.7 | 41.6 | 0.6 | 16.0 | 3.1 | 10.3 |
| Bean meal | 89.1 | 20.2 | 42.3 | 1.3 | 37.1 | 12.0 | 12.9 |
| Cowpea | 85.4 | 16.8 | 54.9 | 1.1 | 32.8 | 10.1 | 12.0 |
| Soy bean | 88.3 | 29.1 | 23.3 | 14.6 | 53.6 | 10.4 | 12.6 |
| Horse bean | 88.7 | 23.1 | 49.8 | 0.8 | 42.6 | 12.0 | 12.9 |

| Name of feed | Total dry matter in 100 lbs | Digestible nutrients in 100 pounds | | | Fertilizing constituents in 1,000 pounds | | |
|---|---|---|---|---|---|---|---|
| | | Crude protein | Carbo-hydrates | Fat | Nitrogen | Phos-phoric acid | Potash |
| Grains, seeds, and their parts—Cont. | Lbs | Lbs | Lbs | Lbs | Lbs | Lbs | Lbs |
| Kafir corn | 90.1 | 5.2 | 44.3 | 1.4 | 17.9 | — | — |
| Sorghum seed | 87.2 | 4.5 | 61.1 | 2.8 | 14.6 | 8.4 | 3.4 |
| Broom corn seed | 87.2 | 4.6 | 42.2 | 1.5 | 15.8 | 7.2 | 5.2 |
| Millet seed | 87.9 | 7.1 | 48.5 | 2.5 | 17.4 | 6.5 | 3.3 |
| Hungarian grass seed | 90.5 | 6.4 | 48.8 | 3.3 | 15.8 | 4.7 | 3.8 |
| Flaxseed | 90.8 | 20.6 | 17.1 | 29.0 | 36.2 | 13.9 | 10.3 |
| Linseed meal (old process) | 90.2 | 30.2 | 32.0 | 6.9 | 54.2 | 16.6 | 13.7 |
| Linseed meal (new process) | 91.0 | 31.5 | 35.7 | 2.4 | 60.0 | 17.4 | 13.4 |
| Cottonseed | 89.7 | 12.5 | 30.0 | 17.3 | 29.4 | 10.5 | 10.9 |
| Cottonseed meal | 93.0 | 37.6 | 21.4 | 9.6 | 72.5 | 30.4 | 15.8 |
| Cottonseed hulls | 88.9 | 0.3 | 33.2 | 1.7 | 6.7 | 4.3 | 10.4 |
| Palm-nut cake | 89.6 | 16.0 | 52.6 | 9.0 | 26.9 | 11.0 | 5.0 |
| Cocoanut cake | 89.7 | 15.4 | 41.2 | 10.7 | 31.5 | 16.0 | 24.0 |
| Sunflower seed | 91.4 | 14.8 | 29.7 | 18.2 | 26.1 | 12.2 | 5.6 |
| Sunflower seed cake | 89.2 | 29.5 | 23.3 | 8.0 | 52.5 | 21.5 | 11.7 |
| Peanut kernels (without hulls) | 92.5 | 25.1 | 13.7 | 35.6 | 44.6 | 12.4 | 12.7 |
| Peanut cake | 89.3 | 42.8 | 20.4 | 7.2 | 76.2 | 20.0 | 15.0 |
| Rapeseed cake | 90.0 | 25.3 | 23.7 | 7.6 | 49.9 | 20.0 | 13.0 |
| Factory by-products | | | | | | | |
| Dried brewers' grains | 91.3 | 20.0 | 32.2 | 6.0 | 40.0 | 16.1 | 2.0 |
| Wet brewers' grains | 23.0 | 4.9 | 9.4 | 1.7 | 10.7 | 4.2 | 0.5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Malt sprouts | 90.5 | 20.3 | 46.0 | 1.4 | 42.1 | 17.4 | 19.9 |
| Dried distillers' grains | 92.4 | 22.8 | 39.7 | 11.6 | 49.9 | 6.0 | 1.7 |
| | | | | | | | |
| Apple pomace | 17.0 | 0.6 | 13.1 | 0.5 | 1.6 | 0.1 | 0.3 |
| Cassava starch refuse | 88.0 | 0.4 | 74.0 | 0.6 | 1.2 | 0.6 | 2.8 |
| Starch refuse | 88.0 | 2.4 | 70.6 | 1.1 | 7.6 | 2.9 | 1.5 |
| Wet starch feed | 31.2 | 3.7 | 12.4 | 2.6 | 8.0 | 0.5 | 0.2 |
| Potato pomace | 7.3 | 0.4 | 6.8 | 0.1 | 0.9 | 0.2 | 0.9 |
| | | | | | | | |
| Wet beet pulp | 10.2 | 0.5 | 7.7 | — | 1.4 | 0.3 | 11.4 |
| Dried beet pulp | 91.6 | 4.1 | 64.9 | — | 12.9 | 2.2 | 3.1 |
| Sugar beet molasses | 79.2 | 4.7 | 54.1 | — | 14.5 | 0.5 | 56.3 |
| Porto Rico molasses | 74.1 | 1.4 | 59.2 | — | 4.3 | 1.2 | 36.8 |
| Dried molasses beet pulp | 92.0 | 6.1 | 68.7 | — | 15.4 | 1.5 | 18.1 |
| Molasses grains | 89.6 | 10.8 | 48.0 | 2.2 | 27.4 | 8.5 | 21.1 |
| | | | | | | | |
| Cow's milk | 12.8 | 3.4 | 4.8 | 3.7 | 5.8 | 1.9 | 1.7 |
| Cow's milk (colostrom) | 25.4 | 17.6 | 2.7 | 3.6 | 28.2 | 6.6 | 1.1 |
| Skim milk | 9.4 | 2.9 | 5.3 | 0.3 | 5.0 | 2.1 | 2.0 |
| Buttermilk | 9.9 | 3.8 | 3.9 | 1.0 | 6.4 | 1.7 | 1.6 |
| Whey | 6.2 | 0.6 | 5.0 | 0.2 | 1.0 | 1.1 | 2.0 |
| | | | | | | | |
| Meat scrap | 89.3 | 66.2 | — | 13.4 | 114.0 | 81.1 | — |
| Meat and bone meal | 94.0 | 36.7 | 5.5 | 10.6 | 63.2 | 146.8 | — |
| Dried blood | 91.5 | 70.9 | — | 2.5 | 135.0 | 13.5 | 7.7 |
| Tankage | 93.0 | 50.1 | — | 11.6 | 86.2 | 139.0 | 3.0 |
| Dried fish | 89.2 | 45.0 | — | 11.4 | 77.4 | 140.0 | 3.0 |
| | | | | | | | |
| Dried roughage | | | | | | | |
| Fodder corn (ears, if any, remaining) | 57.8 | 2.5 | 34.6 | 1.2 | 7.2 | 5.4 | 8.9 |
| Corn stover (ears removed) | 59.5 | 1.4 | 31.2 | 0.7 | 6.1 | 3.8 | 10.9 |
| English hay | 86.0 | 4.5 | 44.0 | 1.2 | 12.6 | 3.2 | 16.1 |
| Hay for mixed grasses | 84.7 | 4.2 | 42.0 | 1.3 | 11.9 | 2.7 | 15.5 |
| Timothy (all analyses) | 86.8 | 2.8 | 42.4 | 1.3 | 9.4 | 3.3 | 14.2 |
| Timothy (cut in full bloom) | 85.0 | 3.4 | 43.3 | 1.4 | 9.6 | 5.0 | 14.1 |
| Timothy (cut soon after bloom) | 85.8 | 2.5 | 39.2 | 1.5 | 9.1 | — | — |
| Timothy (cut nearly ripe) | 85.9 | 2.1 | 40.1 | 1.1 | 8.0 | — | — |

| Name of feed | Total dry matter in 100 lbs | Digestible nutrients in 100 pounds | | | Fertilizing constituents in 1,000 pounds | | |
|---|---|---|---|---|---|---|---|
| | | Crude protein | Carbo-hydrates | Fat | Nitrogen | Phos-phoric acid | Potash |
| Dried roughage—Cont. | Lbs | Lbs | Lbs | Lbs | Lbs | Lbs | Lbs |
| Meadow foxtail | 93.4 | 5.3 | 41.0 | 1.3 | 14.9 | — | — |
| Orchard grass | 90.1 | 4.9 | 42.4 | 1.4 | 12.9 | 3.7 | 16.9 |
| Red top | 91.1 | 4.8 | 46.9 | 1.0 | 12.6 | 3.6 | 10.2 |
| White top | 86.0 | 6.8 | 40.6 | 1.5 | 17.9 | — | — |
| Meadow fescue | 80.0 | 4.2 | 36.9 | 1.5 | 11.2 | 4.0 | 21.0 |
| Kentucky blue grass | 86.0 | 4.4 | 40.2 | 0.7 | 12.5 | 4.0 | 15.7 |
| Tall oat | 86.0 | 3.3 | 41.4 | 1.1 | 10.3 | — | — |
| Italian rye grass | 91.5 | 4.5 | 43.4 | 0.9 | 12.0 | 7.6 | 24.6 |
| Perennial rye grass | 86.0 | 6.1 | 37.8 | 1.2 | 16.2 | 7.4 | 24.1 |
| Rowen hay | 86.0 | 7.9 | 42.2 | 1.4 | 18.2 | 4.3 | 14.9 |
| Bermuda grass | 92.9 | 6.4 | 44.9 | 1.6 | 17.1 | — | — |
| Johnson grass | 89.8 | 2.9 | 45.6 | 0.8 | 11.5 | — | — |
| Macaroni wheat | 93.0 | 4.4 | 48.7 | 0.8 | 10.9 | — | — |
| Barley | 85.0 | 5.7 | 43.6 | 1.0 | 14.1 | — | — |
| Oat | 86.0 | 4.7 | 36.7 | 1.7 | 14.2 | 6.7 | 25.4 |
| Emmer (speltz) | 93.4 | 7.0 | 43.9 | 0.6 | 17.1 | — | — |
| Barnyard millet | 86.0 | 5.2 | 38.6 | 0.8 | 16.9 | 4.3 | 28.8 |
| Hungarian grass | 86.0 | 5.0 | 46.9 | 1.1 | 12.1 | 4.3 | 15.4 |
| Wild oat grass | 85.7 | 2.9 | 48.7 | 1.7 | 8.0 | — | — |
| Prairie grass | 90.8 | 3.0 | 42.9 | 1.6 | 9.9 | — | — |
| Buffalo grass | 85.0 | 3.0 | 42.0 | 1.6 | 7.1 | — | — |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Gama grass | 85.7 | 4.2 | 39.9 | 0.9 | 11.8 | — | — |
| Texas blue grass | 85.7 | 5.1 | 36.3 | 1.4 | 14.6 | — | — |
| Salt marsh grass | 89.6 | 3.1 | 39.7 | 0.9 | 8.8 | 2.5 | 7.2 |
| Ox-eye daisy | 89.7 | 3.7 | 41.0 | 1.7 | 12.3 | 4.4 | 12.5 |
| Australian salt bush | 93.0 | 3.8 | 28.8 | 0.7 | 18.6 | 5.9 | 21.3 |
| | | | | | | | |
| Red clover | 84.7 | 7.1 | 37.8 | 1.8 | 19.7 | 5.5 | 18.7 |
| Red clover in bloom | 79.2 | 7.7 | 34.0 | 2.8 | 19.9 | — | — |
| Mammoth red clover | 78.8 | 6.2 | 34.7 | 2.1 | 17.1 | 5.2 | 11.6 |
| Alsike clover | 90.3 | 8.4 | 39.7 | 1.1 | 20.5 | 5.0 | 13.9 |
| White clover | 90.3 | 11.5 | 42.2 | 1.5 | 25.1 | 7.8 | 13.2 |
| | | | | | | | |
| Crimson clover | 90.4 | 10.5 | 34.9 | 1.2 | 24.3 | 4.0 | 13.1 |
| Japan clover | 89.0 | 9.1 | 37.7 | 1.4 | 22.1 | — | — |
| Sweet clover | 92.1 | 11.9 | 36.7 | 0.5 | 28.8 | 5.6 | 18.3 |
| Soy bean | 88.2 | 10.6 | 40.9 | 1.2 | 23.8 | — | — |
| Cowpea | 89.5 | 9.2 | 39.3 | 1.3 | 14.3 | 5.2 | 14.7 |
| Alfalfa | 91.9 | 10.5 | 40.5 | 0.9 | 23.4 | 6.1 | 17.9 |
| Alfalfa leaves | 95.1 | 16.8 | 35.9 | 1.3 | 37.3 | — | — |
| | | | | | | | |
| Bur clover | 91.0 | 8.2 | 39.0 | 2.1 | 21.8 | — | — |
| Hairy (winter) vetch | 88.7 | 11.9 | 40.7 | 1.6 | 27.2 | 9.7 | 24.4 |
| Peanut vine | 92.4 | 6.7 | 42.2 | 3.0 | 17.1 | 3.2 | 11.6 |
| Velvet bean | 90.0 | 9.6 | 52.5 | 1.4 | 22.4 | — | — |
| Beggar weed | 90.8 | 6.8 | 42.8 | 1.6 | 18.9 | — | — |
| | | | | | | | |
| Sanfoin | 85.0 | 10.4 | 36.5 | 2.0 | 23.7 | 5.0 | 14.7 |
| Wheat and vetch | 85.0 | 10.6 | 36.8 | 1.2 | 23.2 | — | — |
| Oat and pea | 89.5 | 7.6 | 41.5 | 1.5 | 16.5 | 6.1 | 18.1 |
| Oat and vetch | 85.0 | 8.3 | 35.8 | 1.3 | 20.5 | 6.0 | 12.7 |
| Mixed grasses and clover | 87.1 | 5.8 | 41.8 | 1.3 | 16.2 | — | — |
| Mixed rowen | 83.4 | 8.0 | 40.1 | 1.5 | 18.6 | — | — |
| | | | | | | | |
| Straw and chaff | | | | | | | |
| Wheat | 90.4 | 0.8 | 35.2 | 0.4 | 5.0 | 2.2 | 6.3 |
| Rye | 92.9 | 0.7 | 39.6 | 0.4 | 5.0 | 2.5 | 8.6 |
| Oat | 90.8 | 1.3 | 39.5 | 0.8 | 5.8 | 3.0 | 17.7 |

| Name of feed | Total dry matter in 100 lbs | Digestible nutrients in 100 pounds | | | Fertilizing constituents in 1,000 pounds | | |
|---|---|---|---|---|---|---|---|
| | | Crude protein | Carbo-hydrates | Fat | Nitrogen | Phos-phoric acid | Potash |
| Straw and chaff—Cont. | Lbs | Lbs | Lbs | Lbs | Lbs | Lbs | Lbs |
| Barley | 85.8 | 0.9 | 40.1 | 0.6 | 7.0 | 2.0 | 10.6 |
| Millet | 85.0 | 0.9 | 34.3 | 0.6 | 6.5 | 1.8 | 17.3 |
| Buckwheat | 90.1 | 1.2 | 37.4 | 0.5 | 8.0 | 1.3 | 11.4 |
| Field bean | 95.0 | 3.6 | 39.7 | — | — | — | — |
| Soy bean | 89.9 | 2.3 | 40.1 | 1.0 | 6.8 | 2.5 | 10.4 |
| Wheat chaff | 85.7 | 1.2 | 25.4 | 0.6 | 7.2 | 3.8 | 8.2 |
| Oat chaff | 85.7 | 1.5 | 33.0 | 0.7 | 6.4 | 1.4 | 4.5 |
| Fresh green roughage | | | | | | | |
| Fodder corn (all varieties) | 20.7 | 1.0 | 11.9 | 0.4 | 2.9 | 1.1 | 3.9 |
| Dent varieties | 21.0 | 0.9 | 12.2 | 0.4 | 2.7 | — | — |
| Dent (kernels glazed) | 26.6 | 1.1 | 15.0 | 0.7 | 3.2 | — | — |
| Flint varieties | 20.2 | 1.1 | 11.4 | 0.5 | 3.2 | 1.3 | 3.1 |
| Flint (kernels glazed) | 22.9 | 1.5 | 13.2 | 0.6 | 4.3 | — | — |
| Sweet varieties | 20.9 | 1.2 | 12.6 | 0.4 | 3.4 | 1.4 | 3.8 |
| Sweet corn (without ears) | 20.0 | 0.7 | 11.6 | 0.4 | 2.2 | — | — |
| Red kafir corn | 18.4 | 0.8 | 9.7 | 0.4 | 2.9 | 1.3 | 4.5 |
| White kafir corn | 16.6 | 0.9 | 8.3 | 0.5 | 3.0 | 1.2 | 5.0 |
| Teosinte | 9.9 | 0.9 | 4.9 | 0.2 | 2.2 | 0.6 | 9.2 |
| Yellow milo maize | 16.8 | 1.1 | 9.3 | 0.3 | 2.7 | 1.1 | 5.7 |
| Sorghum fodder | 20.6 | 0.6 | 11.6 | 0.3 | 2.1 | 0.7 | 3.4 |
| Sugar cane | 15.8 | 0.5 | 9.5 | 0.3 | 1.9 | 0.9 | 4.4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Fresh green hay | | | | | | | |
| Pasture grass | 20.0 | 2.5 | 10.1 | 0.5 | 5.6 | 2.6 | 7.4 |
| Kentucky blue grass | 34.9 | 2.8 | 19.7 | 0.8 | 6.6 | — | — |
| Timothy | 38.4 | 1.5 | 19.9 | 0.6 | 5.0 | 2.6 | 7.6 |
| Orchard grass | 27.0 | 1.2 | 13.4 | 0.5 | 4.2 | 1.6 | 7.6 |
| Red top (in bloom) | 34.7 | 1.9 | 21.3 | 0.5 | 4.5 | — | — |
| Wheat forage | 22.7 | 1.7 | 12.0 | 0.4 | 3.8 | 1.6 | 6.0 |
| Rye forage | 23.4 | 2.1 | 14.1 | 0.4 | 4.2 | 2.5 | 7.1 |
| Oat forage (in milk) | 37.8 | 2.5 | 18.2 | 1.0 | 5.4 | 1.3 | 3.8 |
| Oat forage (in bloom) | 25.0 | 1.1 | 12.4 | 0.5 | 2.6 | — | — |
| Barley forage | 21.0 | 1.9 | 10.4 | 0.3 | 4.3 | — | — |
| Meadow fescue | 30.1 | 1.6 | 18.6 | 0.5 | 3.8 | — | — |
| Italian rye grass | 26.8 | 1.5 | 12.6 | 0.7 | 5.0 | 2.9 | 11.4 |
| Tall oat grass | 30.5 | 1.2 | 15.7 | 0.5 | 3.8 | — | — |
| Johnson grass | 25.0 | 0.6 | 13.7 | 0.2 | 1.9 | — | — |
| Bermuda grass | 28.3 | 1.3 | 13.4 | 0.4 | 3.5 | — | — |
| Hungarian grass | 28.9 | 2.0 | 15.9 | 0.4 | 5.0 | 1.2 | 4.2 |
| Japanese millet | 25.0 | 1.1 | 13.6 | 0.3 | 3.4 | 2.0 | 3.4 |
| Barnyard millet | 25.0 | 1.6 | 14.4 | 0.3 | 3.8 | 1.1 | 5.8 |
| Pearl millet | 18.5 | 0.6 | 10.0 | 0.2 | 1.9 | 1.5 | 7.1 |
| Common millet | 20.0 | 0.8 | 11.0 | 0.2 | 2.4 | 0.7 | 4.7 |
| Red clover | 29.2 | 2.9 | 13.6 | 0.7 | 7.0 | 1.5 | 4.8 |
| Mammoth red clover | 20.0 | 2.0 | 9.1 | 0.2 | 4.8 | — | — |
| Alsike clover | 25.2 | 2.6 | 11.4 | 0.5 | 6.2 | 1.1 | 2.0 |
| Crimson clover | 19.1 | 2.4 | 9.1 | 0.5 | 5.0 | 1.2 | 4.0 |
| Sweet clover | 20.0 | 2.5 | 8.4 | 0.4 | 6.1 | 2.4 | 6.7 |
| Alfalfa | 28.2 | 3.6 | 12.1 | 0.4 | 7.7 | 1.3 | 5.6 |
| Spring vetch | 15.0 | 1.9 | 6.6 | 0.2 | 4.3 | 1.0 | 4.5 |
| Cowpea | 16.4 | 1.8 | 8.7 | 0.2 | 3.8 | 1.3 | 4.6 |
| Hairy vetch (winter) | 15.0 | 2.8 | 6.4 | 0.3 | 5.8 | 1.4 | 5.2 |
| Hairy vetch (in bloom) | 18.0 | 3.5 | 7.7 | 0.3 | 6.7 | — | — |

| Name of feed | Total dry matter in 100 lbs | Digestible nutrients in 100 pounds | | | Fertilizing constituents in 1,000 pounds | | |
|---|---|---|---|---|---|---|---|
| | | Crude protein | Carbo-hydrates | Fat | Nitrogen | Phos-phoric acid | Potash |
| Fresh green hay—Cont. | Lbs | Lbs | Lbs | Lbs | Lbs | Lbs | Lbs |
| Soy bean | 24.9 | 3.1 | 11.0 | 0.5 | 6.4 | 1.4 | 5.6 |
| Velvet bean | 17.8 | 2.7 | 8.4 | 0.4 | 5.6 | — | — |
| Canada field pea | 15.3 | 1.8 | 6.9 | 0.3 | 4.5 | 1.6 | 5.0 |
| Canada field pea (in bud) | 15.0 | 2.6 | 6.8 | 0.3 | 5.0 | 1.1 | 4.4 |
| Canada field pea (in bloom) | 13.0 | 2.3 | 5.3 | 0.2 | 4.5 | 1.1 | 3.2 |
| Canada field pea (in pod) | 16.0 | 1.9 | 7.0 | 0.2 | 3.7 | 1.3 | 3.7 |
| Barley and vetch | 20.0 | 2.1 | 6.5 | 0.3 | 4.5 | 2.0 | 5.7 |
| Barley and peas | 20.0 | 2.1 | 9.1 | 0.4 | 4.5 | — | — |
| Oats and peas | 20.3 | 1.8 | 10.2 | 0.4 | 3.8 | 1.5 | 5.0 |
| Oats and vetch | 20.0 | 2.3 | 10.0 | 0.2 | 4.8 | 1.4 | 3.0 |
| Wheat and vetch | 20.0 | 2.6 | 10.3 | 0.3 | 5.4 | — | — |
| Mixed grasses and clover | 25.0 | 2.3 | 14.6 | 0.5 | 4.6 | — | — |
| Roots and tubers | | | | | | | |
| Potato | 20.9 | 1.1 | 15.7 | 0.1 | 3.4 | 1.6 | 5.8 |
| Common beet | 11.5 | 1.2 | 7.9 | 0.1 | 2.4 | 0.8 | 4.8 |
| Mangel | 9.1 | 1.0 | 5.5 | 0.2 | 2.2 | 0.9 | 3.8 |
| Sugar beet | 13.5 | 1.3 | 9.8 | 0.1 | 2.9 | 0.9 | 3 7 |
| Flat turnip | 9.9 | 0.9 | 6.4 | 0.1 | 2.1 | 0.9 | 3.4 |
| Carrot | 11.4 | 0.8 | 7.7 | 0.3 | 1.8 | 0.9 | 2.6 |
| Rutabaga | 11.4 | 1.0 | 8.1 | 0.2 | 1.9 | 1.2 | 4.9 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Parsnip | 11.7 | 1.1 | 10.1 | 0.2 | 2.6 | 2.0 | 4.4 |
| Artichoke | 20.5 | 1.3 | 14.7 | 0.2 | 4.2 | 1.4 | 4.7 |
| Sweet potato | 28.9 | 0.8 | 22.9 | 0.3 | 2.4 | 0.8 | 3.7 |
| Chufa | 20.5 | 0.6 | 9.1 | 5.6 | — | — | — |
| Cassava | 34.0 | 0.8 | 28.9 | 0.2 | 2.0 | 1.0 | 4.0 |
| Miscellaneous | | | | | | | |
| Apples | 22.2 | 0.8 | 16.5 | 0.2 | 1.2 | 0.1 | 1.7 |
| Dwarf essex rape | 14.3 | 2.0 | 8.2 | 0.2 | 3.5 | 1.2 | 3.5 |
| Cabbage | 10.0 | 2.3 | 5.9 | 0.1 | 4.2 | 1.1 | 4.3 |
| Sugar beet leaves | 12.0 | 1.9 | 5.0 | 0.2 | 4.2 | 1.5 | 6.2 |
| Field pumpkin | 9.1 | 1.0 | 5.8 | 0.2 | 2.1 | — | — |
| Garden pumpkin | 19.2 | 1.4 | 8.3 | 0.4 | 2.9 | 1.6 | 0.9 |
| Silage | | | | | | | |
| Corn (early analyses) | 20.9 | 0.9 | 11.4 | 0.6 | 2.7 | 1.1 | 3.7 |
| Corn (recent analyses) | 26.4 | 1.4 | 14.2 | 0.7 | 4.3 | 1.1 | 3.7 |
| Corn (ears removed) | 26.3 | 1.1 | 14.9 | 0.7 | 3.5 | — | — |
| Sorghum | 23.9 | 0.1 | 13.5 | 0.2 | 1.3 | 1.5 | 1.9 |
| Millet | 26.0 | 0.2 | 13.1 | 0.6 | 2.7 | 1.4 | 6.2 |
| Rye | 19.2 | 0.7 | 9.0 | 0.2 | 3.8 | — | — |
| Red clover | 28.0 | 1.5 | 9.2 | 0.5 | 6.7 | — | — |
| Canada field pea | 49.9 | 3.4 | 25.5 | 1.0 | 9.4 | — | — |
| Soy bean | 25.8 | 2.7 | 9.6 | 1.3 | 6.6 | 1.6 | 7.5 |
| Cowpea vine | 20.7 | 1.5 | 8.6 | 0.9 | 4.3 | 1.5 | 4.6 |
| Brewers' grains | 29.7 | 4.6 | 11.5 | 1.8 | 10.1 | 4.2 | 0.5 |
| Apple pomace | 15.0 | 0.7 | 9.6 | 0.5 | 1.9 | 1.5 | 4.0 |
| Corn cannery refuse (husk) | 16.2 | 0.4 | 10.1 | 0.4 | 2.2 | — | — |
| Corn cannery refuse (cobs) | 25.9 | 0.3 | 13.7 | 0.9 | 2.4 | — | — |
| Pea cannery refuse | 23.2 | 2.1 | 13.1 | 0.8 | 4.5 | — | — |
| Cowpea and soy bean | 30.2 | 2.2 | 12.9 | 0.8 | 6.1 | — | — |
| Corn and soy bean | 24.0 | 1.6 | 13.2 | 0.7 | 4.0 | 1.5 | 3.6 |
| Barnyard millet and soy bean | 21.0 | 1.6 | 9.2 | 0.7 | 4.5 | 1.1 | 4.4 |

## Kellner Feeding Standards

| Per day per 1,000 pounds live weight | | Digestible substances | | | | |
|---|---|---|---|---|---|---|
| Animal | Dry matter in total ration | Protein | Starch equivalent | Crude protein | Fat | Nitrogen-free extract and crude fiber |
| | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds |
| 1. Full-grown oxen, maintenance diet at rest ......... | 15 to 21 | 0.6 to 0.8 | 6.0 | 0.7 | 0.1 | 7.5 to 9.5 |
| 2. Fattening oxen, full grown...... | 24 to 32 | 1.5 to 1.7 | 12.5 to 14.5 | 1.8 to 2.2 | 0.7 | 13.0 to 16.0 |
| 3. Milk cows | | | | | | |
| Milk yield 10 pounds ......... | 22 to 27 | 1.0 to 1.3 | 7.8 to 8.3 | 1.2 to 1.6 | 0.3 | 9.8 to 10.2 |
| Milk yield 20 pounds ......... | 25 to 29 | 1.6 to 1.9 | 9.8 to 11.2 | 1.9 to 2.3 | 0.5 | 11.5 to 12.8 |
| Milk yield 30 pounds ......... | 27 to 33 | 2.2 to 2.5 | 11.8 to 13.9 | 2.6 to 3.0 | 0.6 | 12.9 to 14.7 |
| Milk yield 40 pounds ......... | 27 to 34 | 2.8 to 3.2 | 13.9 to 16.6 | 3.3 to 3.8 | 0.8 | 13.9 to 15.3 |
| 4. Sheep, full grown, maintenance diet. | | | | | | |
| Coarser breeds.. | 18 to 23 | 1.0 | 8.3 | 1.2 | 0.2 | 10.5 |
| Finer breeds .... | 20 to 26 | 1.2 | 9.0 | 1.5 | 0.2 | 11.0 |
| 5. Fattening sheep, full grown ..... | 24 to 32 | 1.6 | 14.5 | 1.9 | 0.7 | 16.0 |
| 6. Horses | | | | | | |
| Light work ..... | 18 to 23 | 1.0 | 9.2 | 1.2 | 1.4 | 9.8 |
| Medium work .. | 21 to 26 | 1.4 | 11.6 | 1.6 | 0.6 | 11.3 |
| Heavy work .... | 23 to 28 | 2.0 | 15.0 | 2.2 | 0.8 | 13.7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7. Fattening pigs, full grown | | | | | | | |
| First period .... | | 33 to 37 | 3.0 | 27.5 | 3.9 | 0.7 | 26.0 |
| Second period .. | | 28 to 33 | 2.8 | 26.1 | 3.3 | 0.5 | 25.0 |
| Third period .... | | 24 to 28 | 2.0 | 19.8 | 2.6 | 0.4 | 19.0 |
| 8. Growing cattle | | | | | | | |
| (a) dairy cattle | | | | | | | |
| Age in months | Live weight per head | | | | | | |
| 2 to 3 | 150 pounds | 23 | 3.4 | 18.5 | 3.7 | 2.0 | 13.0 |
| 3 to 6 | 300 pounds | 24 | 2.8 | 14.7 | 3.1 | 1.0 | 13.0 |
| 6 to 12 | 500 pounds | 26 | 2.3 | 12.5 | 2.6 | 0.6 | 12.7 |
| 12 to 18 | 700 pounds | 26 | 1.8 | 10.5 | 2.2 | 0.4 | 12.4 |
| 18 to 24 | 900 pounds | 26 | 1.3 | 9.2 | 1.6 | 0.3 | 12.0 |
| (b) Fattening breeds | | | | | | | |
| 2 to 3 | 160 pounds | 23 | 4.5 | 19.5 | 5.0 | 2.3 | 13.2 |
| 3 to 6 | 330 pounds | 24 | 3.5 | 17.4 | 4.0 | 2.0 | 13.0 |
| 6 to 12 | 550 pounds | 26 | 2.8 | 14.4 | 3.2 | 1.0 | 13.0 |
| 12 to 18 | 770 pounds | 26 | 2.2 | 11.2 | 2.6 | 0.5 | 12.5 |
| 18 to 24 | 950 pounds | 26 | 1.5 | 10.0 | 1.8 | 0.4 | 12.0 |
| 9. Lambs | | | | | | | |
| (a) Wool breeds | | | | | | | |
| Age in months | Live weight per head | | | | | | |
| 5 to 6 | 60 pounds | 27 | 3.0 | 16.4 | 3.3 | 0.8 | 15.6 |
| 6 to 8 | 75 pounds | 25 | 2.5 | 13.0 | 2.8 | 0.6 | 13.5 |
| 8 to 11 | 80 pounds | 23 | 1.8 | 10.7 | 2.1 | 0.5 | 11.5 |
| 11 to 15 | 90 pounds | 22 | 1.5 | 10.2 | 1.8 | 0.4 | 11.3 |
| 15 to 20 | 100 pounds | 22 | 1.2 | 9.7 | 1.5 | 0.4 | 11.0 |
| (b) Feeding breeds | | | | | | | |
| 5 to 6 | 65 pounds | 28 | 4.5 | 17.2 | 5.0 | 1.0 | 15.8 |
| 6 to 8 | 80 pounds | 27 | 3.5 | 15.4 | 4.0 | 0.7 | 15.0 |
| 8 to 11 | 100 pounds | 26 | 2.5 | 13.8 | 3.0 | 0.5 | 14.5 |
| 11 to 15 | 120 pounds | 25 | 2.0 | 11.4 | 2.4 | 0.4 | 12.5 |
| 15 to 20 | 150 pounds | 24 | 1.5 | 10.2 | 1.8 | 0.4 | 12.0 |

## Kellner Feeding Standards—*Continued*

| Per day per 1,000 pounds live weight | | | Digestible substances | | | | |
|---|---|---|---|---|---|---|---|
| Animal | | Dry matter in total ration | Protein | Starch equivalent | Crude protein | Fat | Nitrogen-free extract and crude fiber |
| (c) Fattening lambs | | Pounds | Pounds | Pounds | Pounds | Pounds | Pounds |
| 6 to 7 | 65 pounds | 31 | 3.5 | 17.0 | 4.0 | 0.8 | 16.0 |
| 7 to 9 | 88 pounds | 30 | 3.0 | 16.0 | 3.5 | 0.7 | 15.0 |
| 9 to 11 | 110 pounds | 28 | 2.5 | 15.0 | 3.0 | 0.7 | 14.5 |
| 10. Growing pigs | | | | | | | |
| (a) Breeding stock | | | | | | | |
| Age in months | Live weight per head | | | | | | |
| 2 to 3 | 44 pounds | 44 | 6.2 | 33.8 | 6.6 | 1.0 | 28.0 |
| 3 to 5 | 88 pounds | 36 | 4.0 | 27.3 | 5.0 | 0.8 | 23.0 |
| 5 to 6 | 120 pounds | 32 | 3.0 | 23.2 | 3.8 | 0.5 | 21.0 |
| 6 to 9 | 175 pounds | 28 | 2.3 | 20.2 | 3.0 | 0.3 | 19.0 |
| 9 to 12 | 265 pounds | 25 | 1.7 | 15.8 | 2.2 | 0.2 | 15.0 |
| (b) Fattening stock | | | | | | | |
| 2 to 3 | 44 pounds | 44 | 6.2 | 33.8 | 6.6 | 1.0 | 28.0 |
| 3 to 5 | 110 pounds | 36 | 4.5 | 32.0 | 5.6 | 0.9 | 25.5 |
| 5 to 6 | 145 pounds | 32 | 3.5 | 26.5 | 4.4 | 0.7 | 22.5 |
| 6 to 9 | 200 pounds | 28 | 3.0 | 24.5 | 3.9 | 0.5 | 20.5 |
| 9 to 12 | 285 pounds | 25 | 2.4 | 19.8 | 3.2 | 0.3 | 18.5 |

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